

Botanical Department  
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NEW ZEALAND STATE FOREST SERVICE.

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L. MACINTOSH ELLIS, Director of Forestry.

# SOME NEW ZEALAND WOODS.

A Study of the Secondary Wood of Ten Gymnosperms  
and Eighteen Dicotyledons, with Keys to the  
Identification of the Latter.

By

GEORGE A. GARRATT, B.S.,  
in collaboration with the  
STATE FOREST SERVICE.



WELLINGTON.

W. A. G. SKINNER, GOVERNMENT PRINTER.

1924.

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## INTRODUCTION.

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IN 1922 a set of sixty wood-specimens, representing twenty-eight species of trees indigenous to New Zealand, was donated to the Yale School of Forestry by the State Forest Service of New Zealand. At the suggestion of Professor Samuel J. Record, an intensive study of this collection was undertaken by the author, and the ensuing pages embody the results of that investigation.

The descriptions of the woods are treated under two heads—(1) macroscopic, dealing with those features which are visible to the unaided eye and under a hand-lens, and (2) microscopic, based on those characteristics which are discernible with a compound microscope. For the latter work, cross, tangential, radial sections of the woods were prepared, as well as macerated material. Prior to sectioning the wood-samples it was found necessary to immerse them in strong hydrofluoric acid for periods of from three weeks to several months, depending upon the hardness of the wood. By this means the tissues were softened sufficiently for cutting with the microtome. The sections were left unstained, in order to obtain the greatest possible clearness of detail. All mounting was done in glycerine jelly.

The information in regard to the trees and the uses of the woods was compiled from various sources, as listed in the bibliography.

The author wishes to acknowledge his indebtedness to Professor Record for his many kind and helpful criticisms in directing the work.

G. A. G.

## DESCRIPTIVE KEYS TO EIGHTEEN SPECIES OF NEW ZEALAND HARDWOODS.

1. BASED UPON MACROSCOPIC FEATURES AND THOSE VISIBLE UNDER HAND-LENS.
- I. Woods variable from light and soft to moderately hard and heavy (sp. gr. not exceeding 0.762).
- A. Some of rays broad; prominent on cross-section.
1. Woods ring-porous.
- a. Parenchyma fairly distinct as fine lines, adjacent to tangential bands of pores. Colour of wood silver to light brown; aqueous solution light reddish-brown. Ripple marks absent. Sp. gr. 0.737. *Knightia excelsa* (p. 15).
- b. Parenchyma prominent as rather wide tangential bands, embracing pores. Ripple marks present, faintly visible with lens on longitudinal surfaces, 80-90 per inch. Colour of wood dingy-grey to light brown; aqueous solution colourless. Sp. gr. 0.703. *Lacebark* (p. 32).
2. Woods diffuse-porous. Parenchyma not visible. Colour of wood light brown, usually with pinkish tinge; aqueous solution faint brown. Sp. gr. 0.742. *Dracophyllum latifolium* (p. 39).
- B. All rays narrow to minute; not prominent on cross-section.
1. Pores disposed in distinct radial lines. Parenchyma invisible. Colour of wood light brown; aqueous solution light yellowish-brown.
- a. Pores just visible in part to unaided eye; mostly in radial lines of 2-8. Rays fairly distinct on radial surface, somewhat darker than background. Grain straight. Sp. gr. 0.611. *Elaeocarpus dentatus* (p. 29).
- b. Pores usually indiscernible without lens, mostly in radial lines of 2-10 or more. Rays not very distinct on radial surface. Grain rather wavy. Sp. gr. 0.623. *Elaeocarpus Hookerianus* (p. 31).
2. Pores not disposed in radial lines, although often in short radial groups.
- a. Parenchyma in concentric bands or lines; distinct to unaided eye.
- a*<sup>1</sup>. Parenchyma terminal, limiting growth-rings; uniform; whitish. Pores mostly distinct to unaided eye; open. Rays visible without lens on cross-section. Aqueous solution colourless.
- a*<sup>2</sup>. Colour of wood dull greyish-brown. Rays much darker than background on radial surface, prominent. Sp. gr. 0.635. *Beilschmiedia tawa* (p. 19).
- b*<sup>2</sup>. Colour of wood light brown, with distinct pinkish tinge. Rays somewhat darker than background on radial surface; distinct to unaided eye but not prominent. Sp. gr. 0.699. *Beilschmiedia taraire* (p. 21).
- b*<sup>1</sup>. Growth-rings not distinguishable from concentric bands of metatracheal parenchyma. Parenchyma lines somewhat irregular, reddish. Pores commonly filled with white deposits, fairly distinct to unaided eye. Rays indiscernible without lens on cross-section. Colour of wood light reddish-brown; aqueous solution faint brown. Sp. gr. 0.634. *Dysoxylum spectabile* (p. 27).

**b. Parenchyma not in concentric bands.**

- a<sup>1</sup>.** Pores minute, invisible without lens. Wood with pronounced reddish tinge.
- a<sup>2</sup>.** Growth-rings distinct to unaided eye; emphasized by faint ring-porous tendency of vessels. Colour of wood light reddish-brown; aqueous solution practically colourless. *Nothofagus fusca*, *N. Solanderi* (pp. 12-15).
- b<sup>1</sup>.** Growth-rings barely visible to unaided eye. Pores decrease slightly in size toward outside of growth-ring, but lack ring-porous tendency. Colour of wood light brown, usually distinctly tinged with red; aqueous solution light reddish-brown. Sp. gr. 0.703. *Weinmannia racemosa* (p. 25).
- b<sup>1</sup>.** Pores small to minute, visible in part to unaided eye. Wood without reddish tinge; aqueous solution practically colourless.
- a<sup>2</sup>.** Wood moderately hard and heavy; sp. gr. 0.649; colour light brown or dark cream. Apparent growth-rings occasionally indicated by faint ring-porous tendency of vessels, or by rather poreless zones. Parenchyma paratracheal, barely visible with lens. Orange to dark reddish-brown secretory cells faintly visible with lens in rays and wood parenchyma, especially on moist radial section. *Litssea calicaris* (p. 22).
- b<sup>2</sup>.** Wood light and soft; sp. gr. 0.434; colour light buff. Growth-rings mostly rather indistinct to unaided eye. Parenchyma absent. Secretory cells not present. *Laurelia novae-zelandiae* (p. 17).

**II. Woods variable from hard and heavy to extremely so. (Sp. gr. over 0.893.)**

- A.** Pores in radially-inclined lines or patches. Growth-rings distinct to unaided eye; formed by lines of terminal parenchyma. Colour of wood light brown, irregularly streaked with black; aqueous solution practically colourless. Taste rather astringent. Grain straight to slightly wavy. Sp. gr. 1.180. *Olea* sp., prob. *lanceolata* (p. 41).

**B. Pores not radially disposed. Parenchyma invisible.**

- 1.** Rays barely discernible to unaided eye on cross-section. Pores visible in part without lens; solitary, or in radial groups of 2-5. Grain straight to somewhat interwoven. Colour of wood light chestnut-brown, becoming somewhat tinged with green upon exposure; aqueous solution light green. Taste slightly astringent. Sp. gr. 1.024. *Litsea lucens* (p. 43).
- 2.** Rays invisible without lens on cross-section. Pores predominately solitary. Grain straight. Wood deeply coloured; aqueous solution reddish-brown. Taste not distinctive.
- a.** Apparent growth-rings readily visible without lens. Pores open, mostly just discernible to unaided eye, practically confined to rather broad zones of early wood; solitary or rarely in radial groups of 2. Wood hard and heavy; sp. gr. 0.893-0.904; colour chocolate-brown. *Leptospermum scoparium* (p. 37).
- b.** Growth-rings not distinct. Pores mostly filled with white deposits; readily visible to unaided eye; solitary, well distributed. Wood extremely hard and heavy. *Metrosideros* spp.
- a<sup>1</sup>.** Growth-rings invisible. Colour of wood dark brown with slight purplish tinge. Sp. gr. 1.186-1.210. *M. lucida* (p. 35).
- b<sup>1</sup>.** Growth-rings at times vaguely indicated by rather indistinct difference in colour of apparent early and late wood. Colour of wood chocolate-brown. Sp. gr. 1.137. *M. robusta* (p. 36).

## 2. BASED UPON MINUTE ANATOMY.

I. Pores localized in distinct tangential rings or bands (ring-porous). Vessels with exclusively simple perforations; intervacular pits screw-head in appearance. Fibre-pits small and indistinctly bordered. Parenchyma in concentric lines or bands. Some of rays very broad; rather few on cross-section; heterogeneous.

- A. Vessels without spirals; pits into ray cells half-bordered. Fibres frequently with faint spirals in tips; at times falsely septate with horizontal resin-plates; without mucilaginous layers. Parenchyma in distinct terminal lines adjacent to rings of pores, 1-5 cells wide; rarely diffuse; 2-8 (mostly 4) cells per strand. Broad rays few on cross-section (1 or less per millimetre), 0.171-0.975 mm. wide and 2.5-22.2 mm. high; unisexual, 1-6 between wide rays, 1-7 (mostly 1-2) cells high. *Knightia excelsa* (p. 15).
- B. Vessels with spirals; pits into ray cells simple or seldom indistinctly half-bordered. Fibres without spirals; resin-plates absent; mucilaginous layers frequent. Parenchyma in wide metatracheal bands, embracing pores; 2, or rarely 3-4, cells per strand; strands in distinct horizontal seriation with vessel-segments, and usually in somewhat irregular secondary seriation among themselves. Broad rays few, 0.026-0.26 mm. wide and 0.10-1.76 mm. high; unisexual sporadic in occurrence, 1-8 cells high. *Lacebark* (p. 32).

II. Pores diffuse; occasionally more numerous or slightly larger in early wood, but not forming distinct tangential rings or bands.

- A. Pores in radial arrangement. Vessels with spirals. Fibre-pits small and indistinctly bordered.
1. Pores in irregular radial or diagonal lines or patches, in association with tracheids; not radially appressed. Vessel-ray pits half-bordered. Fibres frequently with mucilaginous layers. Middle lamella not distinctly thickened at corners. Parenchyma mostly in terminal lines, 1-3 cells wide, limiting growth-rings; sporadically paratracheal. Rays fairly numerous on cross-section (5-9 per millimetre); 1-3 cells wide; 1-24 cells high; heterogeneous, or more often homogeneous; no crystals observed. *Olea* sp. prob. *lanceolata* (p. 41).
  2. Pores in regular radially-appressed lines. Tracheids absent. Vessel-ray pits simple, or occasionally half-bordered. Fibres without mucilaginous layers. Middle lamella commonly thickened at corners; greenish-yellow in colour. Parenchyma rare, diffuse. Rays very numerous on cross-section; 1-6 cells wide and 1 to many cells high; wide rays frequently with short to fairly long unisexual tips; heterogeneous; crystals common. *Elaeocarpus* spp.
- a. Pores in radial lines of 2-10, or occasionally more. Growth-rings produced by single tangential rows of thin-walled enlarged fibres; at times emphasized by flattened condition of adjacent fibres. Rays 11-16 per millimetre on cross-section; unisexual 1-15 cells high; vertically-elongated cells (on longitudinal sections) subdivided horizontally into 2-4 chambers, part of which contain crystals. *Elaeocarpus dentatus* (p. 29).
- b. Pores in radial lines of 2-25 or more. Growth-rings formed by slightly flattened condition of fibres at termination of late wood. Rays 16-20 per millimetre on cross-section; unisexual, 1-30 cells high; vertically-elongated cells subdivided into 2. *Elaeocarpus Hookerianus* (p. 31).

- B. Pores not in distinct radial lines, although often in short radial groups of 2-5. Vessels without spirals.
1. Vessels with predominately or exclusively scalariform perforations; intervacular pits inclined toward scalariform. Fibre-pits distinctly bordered. Middle lamella frequently thickened at corners. Parenchyma sparingly developed or absent. Rays heterogeneous.
  - a. Vessel-perforations normally scalariform with many bars, very rarely simple. Vessel-ray pits indistinctly half-bordered, or more often simple; scalariform. Fibres with large bordered pits; mucilaginous layers frequent; horizontal resin-plates common. Growth-rings formed by narrow, irregular, rather poreless zones. Parenchyma absent. Rays fairly numerous on cross-section (5-8 per millimetre); 1-4 cells wide; uniseriate, 1-8 cells high; multiseriate 6-64 cells high, occasionally with short uniseriate tips. *Laurelia novae-zelandiae* (p. 17).
  - b. Vessels with exclusively scalariform perforations. Fibres with small bordered pits; mucilaginous layers absent. Parenchyma present.
  - a<sup>1</sup>. Vessels without resin-plates; spiral striations on walls not visible; pits into ray cells simple or rarely half-bordered, and usually scalariform; perforations with 16-34 bars. Fibres without resin-plates. Growth-rings produced by slight thickening of fibre-walls at termination of late wood. Parenchyma rather sparsely developed; diffuse and somewhat metatracheal; 2-6 cells per strand; crystals rare. Rays very numerous on cross-section (14-19 per millimetre); uniseriate, 1-22 cells high; multiseriate not prominent, 3-4 (occasionally more) cells wide and 8-32 cells high, usually with short to fairly long uniseriate tips. *Weinmannia racemosa* (p. 25).
  - b<sup>1</sup>. Vessel-walls marked with spiral striations; horizontal resin-plates occasional; pits into ray cells apparently simple and frequently distinctly scalariform; perforations with 14-45 bars. Fibres frequently falsely septate with resin-plates. Growth-rings formed by distinctly flattened fibres at termination of late wood. Parenchyma sparsely developed, entirely diffuse; 2 cells per strand; crystals absent. Rays of two distinct sizes; uniseriate very numerous on cross-sections (18-22 per millimetre) and 1-20 (mostly 1-8) cells high; multiseriate conspicuous, few on cross-section, 8-13 cells wide and 1.539-31.85 mm. high. *Dracophyllum latifolium* (p. 39).
2. Vessels with predominately or exclusively simple perforations.
- a. Fibre-pits distinctly bordered. Middle lamella commonly thickened at corners, yellowish. Growth-rings produced by flattened condition of fibres at termination of late wood. Parenchyma rather sparsely developed; 2-4 cells per strand. Rays very numerous on cross-section (10-19 per millimetre); 1-3 cells wide (occasionally 4 in part); multiseriate, usually with short to fairly long uniseriate tips; heterogeneous; pits into vessels half-bordered.
  - a<sup>1</sup>. Intervacular pits spirally or irregularly disposed. Fibres without mucilaginous layers; pits large. Parenchyma diffuse, metatracheal, and paratracheal; metatracheal rarely more than 1 cell wide; paratracheal 1, or rarely 2, cells wide. Uniseriate rays 1-30 cells high; multiseriate 6-50 cells high in broad portions. *Leptospermum scoparium* (p. 37).
  - b<sup>1</sup>. Intervacular pits often in more or less vertical rows. Fibres very frequently with mucilaginous layers; pits rather small. Parenchyma diffuse and metatracheal; metatracheal rarely more than 1 cell wide. Uniseriate rays 1-28 cells high; broader ones 4-27 cells high in multiseriate portions. *Metrosideros lucida*, *M. robusta*. (pp. 35-37).

b. Fibre-pits simple (at times very indistinctly bordered in *Vitex lucens*).

a<sup>1</sup>. Vessels with tyloses; pits into ray cells simple or half-bordered. Growth-rings produced by flattened condition of fibres at termination of late wood. Fibres frequently falsely septate with resin-plates. Middle lamella not thickened at corners. Parenchyma sparsely developed. Rays 1-3 cells wide.

a<sup>2</sup>. Tyloses not pitted. Vessels occasionally with scalariform perforations of 20-30 bars; walls not marked with spiral striations. Fibres frequently with colourless, mucilaginous layers. Parenchyma diffuse; 4 cells per strand; crystals occasionally present. Rays numerous on cross-section (10-15 per millimetre); 1-38 cells high; heterogeneous. *Nothofagus* spp.

a<sup>3</sup>. Fibres devoid of contents. Rays uniseriate or less often biseriate. *Nothofagus fusca* (p. 12).

b<sup>3</sup>. Tips of fibres often filled with dark-brown deposits. Rays mostly biseriate (in whole or in part), although frequently uniseriate or triseriate in part. *Nothofagus Solanderi* (p. 14).

b<sup>2</sup>. Tyloses pitted. Vessels with exclusively simple perforations; walls at times marked with spiral striations. Fibres without mucilaginous layers; frequently falsely septate with resin-plates. Parenchyma sporadically paratracheal and occasionally diffuse; 2-4 cells per strand; crystals absent. Rays fairly numerous on cross-section (4-7 per millimetre); up to 51 cells high; occasionally homogeneous. *Vitex lucens* (p. 43).

b<sup>1</sup>. Vessels without tyloses. Middle lamella often thickened at corners. Rays heterogeneous.

a<sup>2</sup>. Vessels without spiral striations on walls; pits into ray cells half-bordered and not scalariform; segments in distinct radial seriation. Fibres distinctly septate; cross-walls numerous. Middle lamella same colour as fibre-walls. Growth-rings not distinguishable from close concentric bands of parenchyma. Parenchyma metatracheal and paratracheal; metatracheal abundantly developed, 1-6 cells wide; paratracheal sporadic; 4-8 (mostly 8) cells per strand. Secretory cells absent. Rays 1-3 cells wide, 1-32 cells high; rather numerous on cross-section (9-12 per millimetre). *Dysoxylum spectabile* (p. 27).

b<sup>2</sup>. Vessel-walls at times marked with faint spiral striations; pits into ray cells simple or half-bordered, and at times distinctly scalariform segments not in radial seriation. Fibres not septate. Middle lamella greenish or yellowish. Growth-rings discernible. Secretory cells present.

a<sup>3</sup>. Fibres frequently with mucilaginous layers. Growth-rings rather indistinct; formed by thickened condition of walls of fibres at termination of late wood. Parenchyma rather sparsely developed; rarely diffuse; mostly paratracheal, 1-3 cells wide. Secretory cells in both rays and parenchyma strands; limited to marginal cells of rays and single cells of parenchyma strands; dark reddish-brown, yellow, or colourless. Rays fairly numerous on cross-section (4-8 per millimetre); predominately multi-seriate, 2-4 cells wide, 4-32 cells high, without uniseriate tips; occasionally inconspicuously uniseriate, 1-4 cells high. *Litsea calicaris* (p. 22).

- b*<sup>3</sup>. Fibre-walls without mucilaginous layers. Growth-rings very distinct. Parenchyma well developed; terminal, paratracheal, and diffuse; paratracheal 1-4 (mostly 1-3) cells wide; diffuse occasional. Secretory cells confined to wood parenchyma; usually filling entire strands. Uniserrate rays inconspicuous, 1-9 cells high; multiserrate with rather short, uniserrate tips, 4 to many cells high in broad portions. *Beilschmiedia* spp.
- a*<sup>4</sup>. Fibres without resin-plates. Terminal parenchyma 3-6 (mostly 3-5) cells wide. Multiserrate rays few on cross-section (2-5 per millimetre), 2-8 cells wide; uniserrate few (0-3 between broad rays). Secretory cells deep yellow in colour. *Beilschmiedia tawa* (p. 19).
- b*<sup>4</sup>. Fibres at times falsely septate with resin-plates. Terminal parenchyma 1-6 (mostly 2-3) cells wide. Rays fairly numerous on cross-section (6-11 per millimetre); multiserrate, 2-3 cells wide. Secretory cells with practically colourless contents. *Beilschmiedia taraire* (p. 21).

# SOME NEW ZEALAND WOODS.

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## I. FAGACEAE.

THE Fagaceae, or beech family, consists of six genera and over four hundred species. To it belong the beeches, oaks, and chestnuts, some of the best-known and most important timber-trees of the world. Five of the genera occur in the Northern Hemisphere; the sixth, *Nothofagus*, which is separated from *Fagus* to receive the antarctic beeches of the Southern Hemisphere, is limited in its distribution to the southern part of temperate Andean South America, New Zealand, Tasmania, and south-eastern Australia. It is represented in New Zealand by six arborescent species.

Structural characteristics of the wood are not very constant throughout the family as a whole, although they are distinctive for groups. The vessels vary in arrangement and size; the perforations exhibit a scalariform tendency; the pits are either simple or half-bordered when in contact with the rays. The wood fibres bear bordered pits, except in *Nothofagus*. Some of the rays are broad in *Fagus* and *Quercus*, and all are narrow (1- to 4-seriate) in the other genera.

**Nothofagus fusca** Oerst. (= *Fagus fusca* Hook. f.). TOOTH-LEAVED BEECH, TAWHAI-RAU-NUI, TAWAI (Auckland), BLACK-BIRCH (Auckland), BROWN-BIRCH (Nelson, North Canterbury), RED-BIRCH (Southland), RED-BEECH (Otago), HUTU TAWHAI.

The tooth-leaved beech is of wide occurrence throughout both North and South Islands, from sea-level to 4,000 ft. elevation. It reaches a height of over 100 ft. in its best development. The great durability of the wood, together with its strength, especially the ability to withstand a high transverse strain, make it highly valuable for house and bridge construction, as well as for fresh-water piling, poles and cross-arms, mine-props, fencing, railroad-ties, and paving-blocks. It is also used for distillation, and is said to have possibilities as a pulp-wood. The bark yields a valuable tannin.

### MACROSCOPIC FEATURES.

*General Properties.*—Wood moderately hard and heavy, rather easily worked; sp. gr. (air-dry), 0.757 to 0.762; weight, 47.3 lb. to 47.6 lb. per cubic foot (53½ lb.—Stone). Grain fairly straight; texture fine and even. Colour light reddish-brown; lustre dull. Aqueous solution practically colourless. Odour and taste not distinctive.

*Growth-rings* distinct to unaided eye on cross-section, appearing as close to rather wide light-coloured lines; fairly well defined on longitudinal surfaces; formed by difference in density between early and late wood, and emphasized by faint ring-porous tendency of pores.

*Parenchyma* present, but indiscernible without microscope.

*Pores* invisible without lens, small to minute; numerous, solitary, or often in small usually radial groups of 2 to 5; open; disposed in almost continuous rings at beginning of early wood, and diminishing somewhat in size toward outside of growth-rings.

*Vessel-lines* barely discernible with unaided eye, minute; about same colour as background.

*Rays* numerous, minute, low; barely perceptible without lens on cross-section; slightly darker than background, and rather faintly visible to unaided eye on radial surface; indiscernible even with lens in tangential views.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are numerous, solitary, or often in small, usually radially-appressed groups of 2 to 5, and irregularly distributed, being disposed in fairly distinct rings, at the beginning of the early wood. They vary in tangential diameter from 0.018 mm. to 0.113 mm., diminishing somewhat in size toward the outside of the growth-rings. The walls are commonly about as thick as those of the fibres, and the solitary pores are very irregular and mostly angular in outline. The horizontal cross-walls of the tyloses frequently appear as almost colourless deposits.

The vessel-segments, as seen on longitudinal sections and in macerated material, are irregular in outline, with short to somewhat extended tongue-like projecting tips. The end walls of the segments are usually very oblique, and the openings are elongated-elliptical. Although occasionally scalariform, with about 20 to 30 anastomozing bars, the perforations are predominately simple. The vessels commonly contain light-brown tyloses, which are usually cylindrical in shape, with horizontally-inclined cross-walls.

Pits are the sole markings on the vessel-walls. Those between vessels are small and numerous, and frequently so crowded that the otherwise circular, or more or less elongated, borders assume a rectangular outline. Their typical arrangement is opposite, and in rare cases they are scalariform. The narrow lenticular, horizontally-inclined mouths extend almost to the borders. The simple or indistinctly half-bordered vessel-ray pits are mostly rather large, horizontally elongated, and opposite, frequently being distinctly scalariform.

*Wood Fibres*.—Libriform wood fibres make up the ground mass of the wood. As viewed on cross-section they are somewhat irregular in outline, although inclined to rectangular, and are disposed in definite radial rows. The size of the fibres is fairly constant throughout a given row, although those cells at the termination of the growth-rings are rather distinctly flattened and have correspondingly smaller lumina. The normal walls of ligno-cellulose are commonly thickened with narrow to wide, irregular, practically colourless, mucilaginous layers. Horizontal resin-plates frequently appear as reddish-brown deposits.

As seen on longitudinal sections and in macerated material the fibres are rather short, slender, and fairly regular cells, usually tapering from near the middle. Their length varies from 0.564 mm.

to 1.283 mm., and the width of the median portion from 0.009 mm. to 0.034 mm. The walls are very thick, due to the gelatinous layers, and the lumina are correspondingly narrow. The fibres are frequently falsely septate by means of horizontal resin-plates. The pits are small, indistinct, and simple.

*Wood Parenchyma*.—The parenchyma is very sparingly developed, occurring as isolated cells, or in very small tangential groups, among the flattened fibres at the termination of the growth-rings. The longitudinal strands are usually made up of 4 cells, which occasionally contain rather dark crystals.

*Rays*.—On cross-section the rays are numerous (10 to 15 per millimetre) and somewhat wavy, due to bending about the pores, with which they are frequently in contact. The individual cells are mostly radially elongated, especially in the broader rays, and commonly contain reddish-brown deposits.

On tangential section the rays are uniserial, or less often biseriate and linear in outline. They are 2 to 38 cells (0.085 mm. to 1.112 mm.) high, and composed of square, or round to slightly axially-elongated, cells.

The rays are heterogeneous on radial section. In the majority the bulk of the cells are procumbent (either short and brick-like or long and very low), only one to several rows of marginal cells being axially elongated. The low rays, however, may be entirely composed of distinctly upright cells.

*Material*.—Yale Nos. 5130, 5141.

**Nothofagus Solanderi** Oerst. (= *Fagus Solandri* Hook. f.). ENTIRE-LEAVED BEECH, TAWHAI-RAU-RIKI, BLACK-BIRCH (Nelson, Canterbury), BLACKHEART (Westland), WHITE-BIRCH (Southland), NEW ZEALAND BEECH, NEW ZEALAND BIRCH, TAWHAI, TAWAI.

A large tree, attaining a height of 100 ft. and a diameter of 4 ft. to 5 ft. It is distributed throughout New Zealand, usually on the higher lands, although in the South Island it frequently grows in low-lying localities. Although said to be less durable than the wood of the tooth-leaved beech, that of the entire-leaved species is used for practically the same purposes, and, in addition, for wheelwright's work, shingles, laths, and log culverts.

The wood very closely resembles that of *N. fusca* both in general appearance and in minute anatomy. The only available specimen, however, is slightly lighter in weight, 44.2 lb. per cubic foot (47 $\frac{1}{2}$  lb.—Stone), and distinctly wavy-grained. There is also a slight difference in the width of the rays as seen with the microscope, those of *N. Solanderi* being mostly biseriate (in whole or in part), although frequently uniserial and rarely triseriate in part. The tips of the fibres of *N. Solanderi* are often filled with dark-brown deposits.

The following measurements were recorded: Tangential diameter of pores, 0.023 mm. to 0.093 mm.; length of wood fibres, 0.462 mm. to 1.351 mm.; width of fibres (median portion), 0.014 mm. to 0.037 mm.; height of rays (1 to 36 cells), 0.051 mm. to 1.043 mm.

*Material*.—Yale No. 5136.

## 2. PROTEACEAE.

The Proteaceae, or silky-oak family, consists of about fifty genera and nearly a thousand species of highly interesting plants, unsurpassed for ornamental purposes, but their economic usefulness is limited to a small number of fancy woods and a few edible nuts. The family is fairly well represented throughout the Southern Hemisphere, although it is largely Australian. But two important genera, *Knightia* and *Persoonia*, occur in New Zealand, each being represented by a single tree species.

The anatomical features which characterize the wood of the Proteaceae are highly distinctive. The vessels are small, and disposed in concentric bands or festoons, in association with parenchyma; the perforations are simple. The wood fibres are thick-walled, and bear bordered pits. The medullary rays are broad and prominent, appearing on the tangential surface as spindle-shaped masses in an irregular fibre meshwork, and giving rise to conspicuous silver-grain on radial section.

**Knightia excelsa** R. Br. REWAREWA, HONEYSUCKLE (Wellington), NEW ZEALAND HONEYSUCKLE.

Rewarewa is confined in its distribution to the North Island, where it attains a height of 100 ft. and a diameter of 3 ft. The wood is valuable for all purposes in which beauty of figure is an important consideration, and is used in the manufacture of furniture, veneers, interior finish, and fixtures, as well as for cabinet-work, turnery, and inlaying. It is also in demand for brake-shoes, and, being easily split, for shingles and fence-rails.

## MACROSCOPIC FEATURES.

*General Properties*.—Wood moderately hard and heavy; easily worked; sp. gr. (air-dry), 0.737; weight, 46.1 lb. per cubic foot (46½-50½ lb.—Stone). Grain straight to slightly wavy; texture fine and even. Colour silver to light brown; conspicuously marked on all sections with pinkish to dark-brown rays; lustre dull. Aqueous solution light reddish-brown. Odour and taste not distinctive.

*Growth-rings* distinct to unaided eye on cross-section, appearing as very close narrow bands, more or less concave between wide rays; formed by rings of pores and adjacent lines of terminal parenchyma.

*Parenchyma* present as fine lines, limiting the rings of growth; fairly distinct without lens on cross-section; scarcely discernible in tangential view; rather distinct as light-brown patches against lighter background on radial surface.

*Pores* practically invisible to unaided eye, small to minute; distinctly ring-porous in arrangement, being disposed in narrow, often broken tangential rows, interrupted by broad rays; mostly in contact laterally and crowded; open.

*Vessel-lines* fairly distinct with unaided eye, narrow, slightly darker than background.

*Rays* of two distinct kinds: (1) Very wide, high, and conspicuous, and (2) extremely narrow, low, and practically indiscernible. Large rays few; pink to dark brown; very conspicuous on all sections, producing pronounced silver-grain on radial. Small rays barely

visible with lens on cross-section; one to several between large rays; slightly darker than background, but rather indistinct to unaided eye on radial surface; indiscernible in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are in distinct ring-porous arrangement, being disposed in more or less broken tangential rows between the broad rays. They are single, or more often crowded together tangentially; occasionally they are in radial groups of two. The individual pores are very irregular and angular in outline, although the small ones often appear somewhat rectangular, and vary in tangential diameter from 0.020 mm. to 0.156 mm. The walls are thinner than those of the fibres. The lumina are open.

The vessel-segments, as seen on longitudinal sections and in macerated material, are somewhat variable in size and shape, but mostly rather long and irregular, with short to rather extended tongue-like projections at both ends. The end walls of the segments are oblique, the openings oval, and the perforations exclusively simple.

Pits are the sole markings on the vessel-walls. Those between vessels are distinctly bordered, and ordinarily have a more or less screw-head appearance, due to the narrow-lenticular mouths, which usually extend somewhat obliquely to the circular borders. They are very small, numerous but not crowded, and normally alternate in disposition. The half-bordered vessel-ray pits are practically identical with the intervacular ones.

*Wood Fibres.*—Libriform wood fibres make up only about half the groundmass of the wood. As viewed on cross-section they are polygonal (four- to eight-sided) in outline, and disposed in very indistinct radial rows.

As seen on longitudinal sections and in macerated material the fibres are rather long, wide, regular cells, usually tapering to sharp points from near the middle. Their length varies from 0.633 mm. to 2.685 mm., and the width of the medium portion from 0.025 mm. to 0.051 mm. The walls are rather thick, and the lumina fairly narrow. The fibres occasionally contain light-brown deposits, and at times are falsely septate by means of horizontal resin-plates. Faint, close spirals are frequently found in the narrow tips. The pits are small and somewhat indistinctly bordered, with vertically-inclined slit-like mouths, which exceed the borders. They are mostly confined to the radial walls, and well distributed throughout the enlarged portion of the fibres.

*Wood Parenchyma.*—The parenchyma occurs as (1) fairly well developed bands at the termination of the growth-rings, 1 to 5 (mostly 2 to 4) cells in width, and (2) rarely isolated cells scattered among the wood fibres. The individual cells, on cross-section, are mostly slightly smaller than the wood fibres, but much thinner-walled, and are inclined to rectangular in outline. The longitudinal strands of parenchyma are composed of 2 to 8 (mostly 4) cells, which occasionally contain light- to dark-brown deposits.

*Rays.*—The rays are uniserial and multiseriate. On cross-section the multiseriate are very broad and conspicuous, few (0.718 mm. to 1.881 mm. apart), and slightly irregular in outline, due to a tendency to enlarge upon passing through the bands of terminal parenchyma.

The uniserial are somewhat more numerous (1 to 6 between the broad rays), rather irregular, due to bending about the pores, and inconspicuous. The individual cells are fairly uniform and distinctly radially elongated in the broad rays, while in the uniserial they are irregular in shape and but slightly elongated. Light- to dark-brown deposits are common.

On tangential section the multiseriate rays are from 0.171 mm. to 0.975 mm. wide and from 2.5 mm. to 22.2 mm. high, and composed of small subcircular cells. The uniserial rays are 1 to 7 (mostly 1 to 2) cells high, and made up of very narrow, axially-elongated cells, which are acutely pointed at the top and bottom of the rays.

The rays are heterogeneous on radial section. The multiseriate are composed of radially-elongated cells, except for one to several rows of square to slightly upright cells on the margins. The uniserial rays are almost entirely made up of cells which are considerably elongated axially.

*Material*.—Yale No. 5173.

### 3. MONIMIACEAE.

This family consists of over thirty genera and about 350 species of aromatic shrubs and trees, confined chiefly to tropical and subtropical regions of the Southern Hemisphere. In New Zealand there are but two arborescent genera, *Laurelia* and *Hedycarya*, each represented by a single species of tree size.

The vessels are characterized by exclusively scalariform, or seldom simple (*Monimia* and *Peumus*), perforations, a tendency toward scalariform intervacular pits, and large, elliptical, simple to half-bordered vessel-ray pits. The wood parenchyma is sparingly developed or absent, and the rays are narrow (*Atherospermeae*) or broad (*Monimia*). The wood fibres bear simple, small, and indistinctly bordered or distinctly bordered pits.

#### **Laurelia novae-zelandiae** A. Cunn. PUKATEA.

Pukatea is a large tree, confined to low altitudes, often in swamps, throughout the North Island and in the extreme northern part of the South Island. The wood is used for cabinet-work and in the manufacture of furniture, interior trim, fixtures, weatherboards, fencing, broom and brush stocks, and spools.

#### MACROSCOPIC FEATURES.

*General Properties*.—Wood light and soft, very easily worked; sp. gr. (air-dry), 0.434; weight, 27.1 lb. per cubic foot. Grain straight; texture fine and even. Colour light buff; slightly lustrous on radial surface. Aqueous solution practically colourless. Odour and taste not distinctive.

*Growth-rings* mostly rather indistinct to unaided eye, fairly close; formed by slight difference in density between early and late wood.

*Parenchyma* absent.

*Pores* small to minute, barely visible without lens; numerous, crowded; solitary, or more often subdivided into 2 to 4; open.

*Vessel-lines* rather indistinct to unaided eye, very fine; about same colour as background.

*Rays* fairly numerous; narrow to minute; low; visible to unaided eye on cross-section, but not very distinct; slightly darker than background, but not very prominent, either with or without lens, on radial surface; indiscernible in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores), which make up half or more of the groundmass of the wood, are very numerous, well distributed, and frequently crowded, occurring singly, or more often in small irregularly-appressed groups of 2 to 4 or more. The individual pores are polygonal in outline, and vary from 0.020 mm. to 0.127 mm. in tangential diameter. The pore-walls are considerably thinner than those of the fibres. The lumina are oper.

The vessel-segments, as viewed on longitudinal sections and in macerated material, are long and irregular in shape. In the large majority the end walls of the segments are very oblique, the openings elongated-elliptical, and the perforations scalariform with many bars. In rare cases, however, the ends are but slightly oblique, the openings oval, and the perforations simple.

Pits are the sole markings on the vessel-walls. Those between the vessels in which scalariform perforations occur are rather large, few, and usually scalariform in appearance, with narrow slit-like mouths extending horizontally to the inconspicuous borders. In the vessels with simple perforations the intervacular pits are small and rounded in outline, with narrow horizontally-inclined mouths. The indistinctly half-bordered, or more often simple, vessel-ray pits are normally large, few, and distinctly scalariform in appearance.

*Wood Fibres*.—Libriform wood fibres make up less than half of the groundmass of the wood. On cross-section they are irregularly polygonal in outline, and, where the pores permit, are disposed in quite definite radial rows. They are seldom continuous in a tangential direction, except at the termination of the growth-rings, where they occur in very narrow irregular bands. This condition is more readily discernible to the unaided eye and with the lens than under the microscope. The middle lamella is yellowish and frequently thickened at the corners, but, being about the same colour as the fibre-walls, is rather indistinct. The normal ligno-cellulose walls are frequently thickened with mucilaginous inner layers.

As seen on longitudinal sections and in macerated material the fibres are long, rather wide, fairly regular cells, usually tapering gradually to sharp points from near the middle. Their length varies from 1.123 mm. to 2.565 mm., and the width of the median portion from 0.025 mm. to 0.063 mm. The walls are rather thin, except where reinforced by mucilaginous layers, and the lumina are mostly very wide in the central portions. Distinct horizontal resin-plates are of frequent occurrence. The pits are large and very distinctly bordered, with vertically-inclined slit-like mouths, which slightly exceed the subcircular borders. They are numerous and well distributed throughout the enlarged portion of the fibres, occurring in both the radial and tangential walls.

*Rays*.—On cross-section the rays are fairly numerous (5 to 8 per millimetre), and somewhat irregular in outline, due to contact with the pores. The individual cells are radially elongated, especially in the wider rays.

On tangential section the rays are uniserrate to triseriate (at times 4 cells wide in part), the wider ones predominating. The uniserrate rays are 1 to 8 cells high, while the multiseriate, which occasionally have short, uniserrate tips, are 6 to 64 cells (0.274 mm. to 2.137 mm.) in height. The individual cells are rather vertically elongated in the the uniserrate rays, while in the multiseriate they are slightly oval, with the longest axis vertical. The marginal cells in all rays are elongated and somewhat acutely pointed.

The rays are heterogeneous on radial section. The cells in the uniserrate rays and on the uniserrate margins of the broad rays are axially elongated (upright), while those in the multiseriate portions are radially elongated (procumbent).

*Material*.—Yale No. 5168.

#### 4. LAURACEAE.

The laurel family consists of about forty genera and a thousand species of aromatic trees and shrubs, widely distributed throughout the tropical and subtropical regions of the world, with a few representatives in the Temperate Zone. Many of them are very large and important timber-trees, and a great number are rich in aromatic substances and are the source of such well-known products as camphor, cinnamon, cloves. *Beilschmiedia* and *Litsea* are the important genera of this family occurring in New Zealand.

The woods of this family, with the exception of the parasite genus, *Cassytha*, have a number of anatomical features in common. The vessels, which are in diffuse arrangement (except in sassafras), are characterized by perforations, which are often exclusively simple, but usually tend toward scalariform, with few bars. The simple-pitted wood fibres are sometimes septate, and in some genera contain mucilaginous layers. Wood parenchyma may be abundant or sparsely developed. The rays are uniserrate to triseriate, or rarely wider, and exhibit simple or half-bordered pits in contact with the vessels. Secretory cells, with oily contents, are frequently present in the medullary rays and parenchyma of certain genera.

#### ***Beilschmiedia tawa* (= *Nesodaphne tawa* Hook. f.). TAWA, TAU.**

Tawa is distributed throughout the North Island and in the north-eastern part of the South Island, between sea-level and 1,000 ft. elevation, and attains a height of 60 ft. to 70 ft. and a diameter of 1 ft. to 2 ft. The wood is used to considerable extent for cooper's ware, crating-stock, weatherboards, inside house-trim, framing for cheap buildings, furniture, and rotary-cut veneer. It is also used for distillation, and said to have possibilities as a pulp-wood.

#### MACROSCOPIC FEATURES.

*General Properties*.—Wood rather light and soft, easily worked; sp. gr. (air-dry), 0.635; weight, 39.7 lb. per cubic foot (43 $\frac{1}{3}$  lb.—Stone). Grain straight; texture fine and even. Colour dull greyish-brown; rather faint darker tracings on tangential surface. Aqueous solution practically colourless. Odour and taste not distinctive.

*Growth-rings* readily visible to unaided eye, close, uniform; formed by fairly wide bands of terminal parenchyma.

*Parenchyma* terminal and paratracheal; terminal as above; paratracheal barely discernible without lens as narrow zones, encircling pores.

*Pores* mostly visible to unaided eye, small to medium, fairly abundant; evenly distributed; solitary, or in radial groups of 2 to 4; open.

*Vessel-lines* fairly distinct to naked eye; rather narrow; slightly darker than background.

*Rays* rather few; narrow to minute; low; discernible in part to unaided eye on cross-section; deep chocolate-brown on radial surface and very prominent against much lighter background; fairly distinct without lens in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are fairly abundant and irregularly disposed, occurring singly or in small mostly radially-appressed groups of 2 to 4. The solitary pores are round, oval, or angular in outline, and vary in tangential diameter from 0.051 mm. to 0.205 mm. The pore-walls are mostly about as thick as those of the fibres. The lumina are open.

The vessel-segments, as viewed on longitudinal sections and in macerated material, are rather irregular in size and shape, and often have short, rather blunt, projecting tips. The end walls of the segments vary from practically horizontal to oblique, the openings are round to oval, and the perforations are exclusively simple.

Very faint, close, spiral striations are visible in the vessel-walls. The small intervacular pits are distinctly bordered, and have a more or less screw-head appearance. They are usually very numerous, and so crowded that the otherwise rounded border assumes a polygonal outline. Their typical arrangement is alternate, giving a rather distinct spiral effect, emphasized by the slightly oblique condition of the slit-like mouths, which are frequently fused with two or more adjoining orifices. The simple, or predominately half-bordered, vessel-ray pits are quite variable in size and shape, but mostly large and lenticular. They are usually somewhat horizontally inclined, and at times have a rather distinct scalariform appearance. Occasionally one pit in a ray covers two or three in a vessel.

*Wood Fibres*.—Libriform wood fibres make up the groundmass of the wood. On cross-section they are irregularly polygonal in outline, but disposed in distinct radial rows, in which the cells are fairly constant in size. The middle lamella is light green in colour, and often distinctly thickened at the corners.

As seen on longitudinal sections and in macerated material the fibres are mostly short, rather slender, somewhat irregular cells, either tapering to long sharp points from near the centre, or more often having elongated cylindrical median portions, rather abrupt shoulders, and short to fairly long narrow tips. Their length varies from 0.513 mm. to 1.368 mm., and the width of the enlarged portion from 0.011 mm. to 0.041 mm. The walls are of medium thickness. The simple pits are small, numerous, and slit-like or narrow-lenticular. They are confined to the radial walls for the most part, and are distributed throughout the enlarged portion of the fibres.

*Wood Parenchyma*.—The parenchyma is well developed, occurring as (1) fairly regular bands, 3 to 9 (mostly 3 to 6) cells wide, limiting the rings of growth; (2) 1 to 4 (mostly 1 to 3) rows of somewhat flattened irregular cells surrounding the pores; and (3) occasionally solitary cells scattered among the wood fibres. The individual cells, on cross-section, are about the same size as the wood fibres, except for those in the paratracheal rings, which are often considerably larger. The walls, however, are much thinner than those of the fibres. The longitudinal strands of parenchyma are composed of 2, or less often of 3 to 4, cells, which in the terminal strands are about as wide as the wood fibres, but in the paratracheal are considerably enlarged.

*Oil-cells*.—Somewhat enlarged, thin-walled, parenchyma strands, completely filled with deep-yellow deposits, are of frequent occurrence in the terminal and paratracheal parenchyma, and are occasionally isolated among the wood fibres. These are the oil-cells described by Solereder as occurring in the Lauraceae.

*Rays*.—The rays are uniserrate and multiseriate. On cross-section the multiseriate rays are conspicuous, few (2 to 5 per millimetre), and somewhat irregular in outline, due to contact with the pores and a marked tendency to enlarge upon passing through the bands of terminal parenchyma. The uniserrate rays are inconspicuous, few (0 to 3 between successive broad rays), and decidedly bent in contact with the pores. The individual cells are radially elongated and fairly uniform in the broad rays, while in the uniserrate they are considerably shorter and often rather irregular in shape. Brown to black deposits frequently partly fill the cells.

On tangential section the uniserrate rays are 1 to 9 cells (0.051 mm. to 1.30 mm.) high. The multiseriate rays, which frequently have rather short uniserrate tips, are 2 to 8 cells (0.025 mm. to 0.171 mm.) wide and 4 to many cells (0.128 mm. to 1.45 mm.) high in the multiseriate portions. The individual cells in the uniserrate rays and uniserrate portions of the mixed rays are square to somewhat vertically elongated, while those in the multiseriate rays and the multiseriate portions of the mixed rays are small and irregularly subcircular in outline. The cells at the top and bottom of all rays are obtusely or acutely pointed.

The rays are heterogeneous on radial section. The cells in the central portion of the wide rays are radially elongated (procumbent), while those on the uniserrate margins and in the uniserrate rays are axially elongated (upright).

*Material*.—Yale No. 5170.

#### **Beilschmiedia taraire** (= *Nesodaphne taraire* Hook. f.). TARAIRE.

Taraire is very limited in its distribution, occurring only in the extreme northern part of North Island (north of the City of Auckland). The wood has much the same uses as that of tawa.

The wood of *B. taraire*, while very similar to that of *B. tawa*, has several outstanding characteristics. It is slightly heavier in weight (sp. gr., 0.699; weight, 43.7 lb. per cubic foot), and light brown in colour, with a distinct pinkish tinge. The rays are less prominent on all sections, especially on the radial, where they are light brown in colour, and, although distinct to the unaided eye, not prominent.

In minute structure there are a number of outstanding differences. The wood fibres are somewhat longer and slightly wider (0.754 mm. to 2.018 mm. long, and 0.022 mm. to 0.045 mm. wide), and are at times falsely septate by means of horizontal resin-plates, and occasionally contain dark-brown deposits. The terminal parenchyma is but 1 to 6 (mostly 2 to 3) cells in width, and the longitudinal parenchyma strands are composed of 2 to 5 cells. The contents of the oil-cells are practically colourless. The rays are fairly numerous on cross-section (6 to 11 per millimetre), and on tangential section the multiseriate ones are found to be but 2 to 3 cells (0.026 mm. to 0.091 mm.) in width. The other measurements recorded are as follows: Diameter of pores, 0.042 mm. to 0.229 mm.; width of paratracheal parenchyma, 1 to 4 (mostly 2 to 4) cells; height of uniseriate rays, 1 to 8 cells; height of multiseriate rays (6 to 30 cells), 0.154 mm. to 1.197 mm.

*Material.*—Yale No. 5171.

**Litsea calicaris** Kirk (= *Tetranthera calicaris* Hook. f.; *T. tangao* R. Cunn.). MANGEAO, TANGEAO.

Mangeao is confined to the extreme northern part of North Island, occurring mostly on the east and west coast of Auckland Province. The wood is suitable for a great variety of purposes which require strength, toughness, and elasticity, combined with light weight. It is important in the manufacture of agricultural machinery, both for framework requiring considerable transverse strength as well as durability, and for working-parts demanding straight-grained, fairly tough, and springy woods. It is also used for pick-handles, ship's blocks, wheelwright's work, bullock-yokes, cooper's ware, light framing for machinery, and interior finish for electric and railway cars.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light, but fairly hard and tough; sp. gr. (air-dry), 0.649; weight, 40.6 lb. per cubic foot (38–48 lb.—Howard). Grain straight, texture fine and even. Colour light brown or dark cream; lustre dull. Solution practically colourless. Odour and taste not distinctive.

*Growth-rings* not distinct, although apparent growth-rings are occasionally indicated by faint ring-porous tendency on part of larger pores, and at times by rather poreless zones of wood, which, to unaided eye, appear slightly darker than background. True growth-rings are present, but are produced by difference in wood fibres and visible only with microscope.

*Parenchyma* barely discernible with lens as fine rings about pores.

*Pores* mostly visible to naked eye, small to minute, numerous; regularly distributed, except for occasional slight ring-porous tendency on part of larger pores, and rather infrequent irregular poreless bands; solitary or frequently in radial groups of 2 to 4; open.

*Vessel-lines* visible to unaided eye, but not distinct; narrow; slightly darker than background.

*Rays* fairly numerous, narrow, low; visible without lens on cross and tangential sections, but not distinct; slightly darker than background, and fairly distinct on radial surface.

*Secretory cells* faintly discernible with lens in rays and wood parenchyma on all sections, but especially on radial; minute; orange to dark reddish-brown.

## MICROSCOPIC FEATURES.

*Vessels.* — On transverse section the vessels (pores) are fairly numerous and rather irregularly disposed, occurring singly or in small mostly radially-appressed groups of 2 to 4. The solitary pores are round, subcircular, or oval in outline, and vary in tangential diameter from 0.028 mm. to 0.17 mm. The pore-walls are mostly thicker than those of the fibres. The lumina are open.

The vessel-segments, as seen on longitudinal sections and in macerated material, are somewhat variable in size and shape, but mostly short and irregular, and frequently have brief tongue-like projecting tips. The end walls vary from practically horizontal to very oblique, the openings are round to elongated oval, and the perforations are exclusively simple.

Very faint, close, spiral striations are at times visible in the vessel-walls. The intervacular pits are distinctly bordered, and have a screw-head appearance. They are usually very numerous, and mostly so crowded that the otherwise rounded border assumes a polygonal outline. Their typical arrangement appears to be alternate, but frequently they show a tendency toward opposite, and at times are somewhat horizontally elongated, or in rare cases distinctly scalariform. The horizontally-inclined lenticular mouths occasionally expose a perforated condition of the pit-membrane. The simple or half-bordered vessel-ray pits are variable from small and usually opposite to large and mostly horizontally elongated. Often they extend completely across the ray cells, giving a distinct scalariform appearance.

*Wood Fibres.* — Libriform wood fibres make up the groundmass of the wood. On cross-section they are inclined to be quadrangular in outline, being flattened radially, and are disposed in definite rows. There is considerable variation in the size of the fibres, depending upon whether the section passes through the enlarged portions or the constricted ends. However, as a result of the rather distinct radial seriation of the fibres, the size is quite constant throughout a given radial row. Rather indistinct growth-rings are produced by a decided thickening of the fibre-walls at the termination of the late wood. The middle lamella is a greenish-yellow in colour and often prominent at the corners. The normal ligno-cellulose walls are frequently reinforced with mucilaginous layers, usually in the cells producing the growth-rings. Occasionally this thickening is of a brownish colour, emphasizing the rings of growth.

As seen on longitudinal sections and in macerated material the fibres are short, rather wide, somewhat irregular cells, either tapering to long, sharp points from near the middle, or more often having much elongated, cylindrical, median portions, with distinct shoulders, and terminating abruptly in short pointed ends. Their length varies from 0.564 mm. to 1.402 mm., and the width of the enlarged central portion from 0.011 mm. to 0.048 mm. The walls are of medium thickness, except in those cells which produce the growth-rings, and the lumina appear rather wide on the tangential surface, but narrow on the radial, due to the flattened condition of the fibres observed on cross-section. The pits are simple, minute, and barely discernible. They are mostly confined to the radial walls, and distributed throughout the enlarged portion of the fibres.

*Wood Parenchyma*.—On cross-section the parenchyma is found to be rather sparsely developed, occurring mainly about the pores (paratracheal) in 1 to 3 rows of irregular, often flattened cells, and rarely as isolated cells scattered among the fibres (diffuse). The individual cells are quite thin-walled, and mostly somewhat larger than the wood fibres. The longitudinal strands of parenchyma are composed of 2, or at times 3 to 4, cells, which are fairly regular in shape and somewhat wider than the fibres.

*Rays*.—On cross-section the rays are fairly numerous (4 to 8 per millimetre) and rather unevenly distributed, though mostly a pore's width apart. They are inclined to be somewhat wavy, as a result of frequent bending about the pores. The individual cells have usually horizontal end walls and are somewhat radially elongated. In the broad rays they are mostly two to three times as long as broad, while in the uniseriate ones they more nearly approach square. Dark-brown deposits frequently partially fill the cells.

On tangential section the rays are mostly narrowly elliptical in outline, and usually obtusely pointed. They are predominately multiseriate, although inconspicuous uniseriate rays, 1 to 4 cells in height, occasionally occur. The multiseriate rays are 2 to 4 cells (0.0198 mm. to 0.065 mm.) wide and 4 to 32 cells (0.111 mm. to 0.769 mm.) high. The individual cells are small and inclined to round or oval in shape, except for the usually single, enlarged, and pointed end-cells at the top and bottom of each ray.

The rays are heterogeneous on radial section. The cells in the uniseriate rays and on the margins of the multiseriate are mostly axially elongated (upright), while those in the multiseriate portions are slightly radially elongated (procumbent).

*Oil-cells*.—Considerably enlarged parenchyma cells, containing dark reddish-brown, yellow, or colourless substances, are frequently found in the ray and paratracheal parenchyma, and rarely scattered among the fibres. They are confined to the marginal cells of the rays and to a single cell of the strands in which they occur.

*Material*.—Yale No. 5172.

##### 5. SAXIFRAGACEAE.

The Saxifragaceae consists of seventy genera and about six hundred and fifty species, distributed throughout all parts of the world. It is represented in New Zealand by five genera—*Ackama*, *Carpodetus*, *Ixerba*, and *Quintinia*, each with a single species, and *Weinmannia* with two.

There are only a few structural features of the wood common to all members of this family, but, on the other hand, there are numerous anatomical characters for groups and genera. A tendency toward the formation of scalariform perforations is peculiar to all the woody genera, since scalariform perforations are always present, either exclusively or side by side with simple openings. The vessel-ray pits are either entirely bordered or both bordered and simple, and the wood prosenchyma has either bordered or simple pits, or both. The wood parenchyma is sparsely developed, and the rays are variable in breadth, reaching seven cells in *Ribes*.

**Weinmannia racemosa** Linn. f. KAMAHİ, KAMAI (Otago), TOWHAI, TAWHERO (Auckland), TOWAI (Taranaki), BLACK-BEECH (Wellington), BIRCH (Southland).

Kamahi is a medium-sized tree, 40 ft. to 60 ft. in height, distributed throughout both the North and South Islands. It occurs from sea-level to 2,500 ft. elevation, becoming somewhat dwarfed as it ascends the mountains. The wood is rather limited in its uses, but finds a demand in cabinet-work, interior trim, fencing, and mine-timbers. It also has possibilities as a pulp-wood. The bark yields a tannin.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood moderately hard and heavy, rather easily worked; sp. gr. (air-dry), 0.686 to 0.703; weight, 42.9 lb. to 43.9 lb. per cubic foot (45.4 lb.—Stone). Grain straight; texture fine and even. Colour light brown, usually distinctly tinged with red; lustre rather dull. Aqueous solution light reddish-brown. Odour and taste not distinctive.

*Growth-rings* barely visible to unaided eye, very close; scarcely darker than groundmass; formed by slight difference in density between early and late wood.

*Parenchyma* present, but invisible without microscope.

*Pores* indiscernible to unaided eye, minute, numerous, well distributed; slight tendency to decrease in number toward outside of growth-ring; solitary, or occasionally in groups of 2 to 4; open.

*Vessel-lines* barely apparent to unaided eye, minute; same colour as background.

*Rays* numerous, narrow to minute, low; wider ones just visible at times without lens on cross-section; somewhat darker than background and fairly distinct to unaided eye on radial surface; invisible in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are very numerous, solitary or occasionally in small, mostly tangentially-appressed groups of 2 to 4, and rather irregularly disposed, exhibiting a fairly decided tendency to decrease in number toward the outside of the growth-ring. The solitary pores are very irregular in shape, and vary in tangential diameter from 0.019 mm. to 0.071 mm., often being slightly wider (tangentially) than the fibres. The walls are much thinner than those of the fibres. The cavities are open, except for the rare occurrence of localized groups of vessels containing red-brown deposits.

The vessel-segments, as seen on longitudinal sections and in macerated material, are short to rather long and irregular in shape, and usually have tongue-like projecting tips at the ends. The end walls are mostly very oblique, the openings slightly oval to elongated, elliptical, and the perforations exclusively scalariform, with 16 to 34 bars, which are mostly straight and uniform, although occasionally anastomosing.

Pits are the sole markings on the vessel-walls. Those between vessels are small, rather few in number, opposite, and slightly to much elongated horizontally; at times they are distinctly scalariform. The narrowly-elliptical mouths extend almost to the borders. The simple, or rarely half-bordered, vessel-ray pits are rather large and horizontally elongated, usually being scalariform.

*Wood Fibres.*—Libriform wood fibres make up the groundmass of the wood. On cross-section they are polygonal in outline, but mostly inclined to rectangular, and disposed in fairly definite radial rows, throughout which the size of the cells is rather constant. The fibres at the termination of the growth-ring have considerably thicker walls, and correspondingly narrower lumina, than those in the less compact early wood. The middle lamella is light brown in colour, and frequently thickened at the corners. At times the cavities contain light- to dark-brown deposits.

As seen on longitudinal sections and in macerated material, the fibres are short, rather slender, somewhat irregular cells, usually tapering gradually to sharp points from near the middle. Their length varies from 0.633 mm. to 1.607 mm., and the width of the median portion from 0.017 mm. to 0.034 mm. The walls are medium to very thick, and the lumina fairly wide to narrow. The pits are distinctly bordered, with vertically-inclined, narrow-lenticular mouths, which extend mostly or entirely to the circular borders. They are rather small and numerous, and occur in both the radial and tangential walls, being usually disposed in more or less vertical rows throughout the entire length of the fibres.

*Wood Parenchyma.*—On cross-section the parenchyma is sparsely developed, occurring as isolated cells, or short to fairly long, irregular, broken, tangentially-inclined lines, seldom more than 1 cell in width. The individual cells are somewhat smaller than the fibres and much thinner-walled. The longitudinal strands are composed of 2 to 6 cells, which occasionally contain yellow to light-brown deposits. In rare instances these strands are chambered and contain about 18 to 20 small irregularly-polygonal crystals.

*Rays.*—On cross-section the rays are very numerous (14 to 19 per millimetre) and regularly distributed, mostly a pore's width apart. The individual cells are radially elongated, especially in the broader rays. Practically all the cells are mostly or entirely filled with dark-brown deposits.

On tangential section the rays are uniserrate and multiseriate. The former are 1 to 22 cells (0.068 mm. to 1.197 mm.) high, while the latter, which usually have short to fairly long uniserrate tips, are 3 to 4, or occasionally more, cells (0.028 mm. to 0.062 mm.) wide, and 8 to 32 cells (0.291 mm. to 1.214 mm.) high. The individual cells in the uniserrate rays and uniserrate portions of the mixed rays are considerably elongated vertically, while those in the multiseriate rays and multiserate portions of the mixed rays are irregularly suboval, with the longest axis vertical.

The rays are heterogeneous on radial section. The cells in the uniserrate rays and uniserrate margins of the mixed rays are axially elongated (upright), while those in the multiseriate portions are radially elongated (procumbent).

*Material.*—Yale Nos. 5145, 5155, 5155A.

#### 6. MELIACEAE.

The mahogany family consists of about forty genera and over six hundred species of trees, shrubs, and woody herbs, chiefly confined to the tropics. Among the valuable timbers supplied by this family

are the true mahogany and the Spanish, or cigar-box, cedar of tropical America, most of the African mahoganies, the Australian rosewoods, and some excellent timbers of India and the Philippines. A single species, *Dysoxylum spectabile*, attains tree-size in New Zealand.

The woods of the Meliaceae are for the most part reddish in colour, often fragrant, durable, and highly esteemed for cabinet-work. The vessels have simple perforations, and are characterized by the presence of bordered pits, even in contact with the narrow (1-3 seriate) rays. The wood fibres have fairly wide, often septate, lumina, and bear simple pits. The wood parenchyma may be little developed or rather abundant.

**Dysoxylum spectabile** Hook. f. KOHEKOHE, REDHEART, NEW ZEALAND CEDAR (Hawke's Bay).

Kohekohe is a fairly large tree, occurring chiefly in the North Island between sea-level and 500 ft. elevation. The wood is in demand for furniture, cabinet-work, veneers, fixtures, and musical instruments, as well as for shingles and fencing.

MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light and soft, easily worked; sp. gr. (air-dry), 0.634; weight, 39.6 lb. per cubic foot (36-39½ lb.—Stone). Grain straight to wavy; texture fine and even. Colour light reddish-brown; rather inconspicuously marked on longitudinal surfaces with numerous fine slightly darker lines of parenchyma; slightly lustrous on radial surface. Aqueous solution faint light-brown. Odour and taste not distinctive.

*Growth-rings* not distinguishable from concentric bands of metatracheal parenchyma.

*Parenchyma* distinct to unaided eye on cross-section, appearing as numerous wavy, often merging, concentric lines, frequently partly embracing the pores; readily discernible on longitudinal surfaces; sometimes visible with lens as narrow zones about pores.

*Pores* fairly distinct to unaided eye as white dots, small to minute, fairly numerous, well distributed; single or in radial groups of 2 to 6, mostly 2; commonly contain white deposits.

*Vessel-lines* fairly distinct to unaided eye, fine; darker than background when open, lighter when filled with whitish deposits.

*Rays* numerous, narrow to minute, low; indiscernible without lens on cross-section; considerably darker than background, and distinct to unaided eye on radial surface; barely visible with naked eye in tangential view.

MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are fairly numerous and well distributed, occurring singly or in small usually radially-appressed groups of 2 to 6 (mostly 2 to 3), and vary in tangential diameter from 0.037 mm. to 0.156 mm. The solitary pores are mostly oval to slightly angular in outline. The pore-walls are about as thick as those of the fibres. The cavities are frequently partly or entirely filled with light- to dark-brown deposits.

The vessel-segments on longitudinal sections and macerated material are variable from short to rather long and somewhat irregular in shape, and frequently have brief tongue-like projecting tips. The end walls of the segments vary from practically horizontal to very oblique, the openings are rounded to somewhat elongated, and the perforations are exclusively simple. The segments, which are in contact radially, exhibit distinct horizontal seriation.

The intervacular pits are very small and numerous, usually being so crowded that the otherwise rounded border assumes a polygonal outline. Their typical arrangement is alternate, although at times it appears rather variable. The narrow-lenticular mouths are inclined to be somewhat oblique, and at times fused with the orifices of adjacent pits, producing a spiral effect. The distinctly half-bordered vessel-ray pits are about the same size as those between vessels, and are subcircular, fairly numerous, and alternate in disposition.

*Wood Fibres*.—Libriform wood fibres make up the groundmass of the wood. On cross-section they are rather irregularly polygonal in outline, and disposed in very definite radial rows. The middle lamella is often somewhat thickened at the corners, but, being about the same colour as the fibre-walls, is not very distinct.

As seen on longitudinal sections and in macerated material the fibres are short, slender, rather irregular cells, usually tapering unevenly from near the middle. Their length varies from 0.530 mm. to 1.539 mm., and the width of the median portion from 0.011 mm. to 0.040 mm. They are distinctly septate, with numerous cross-walls. The normal walls are of medium thickness, and the lumina fairly wide. The pits are simple, minute, and indistinct.

*Wood Parenchyma*.—The parenchyma is abundantly developed in numerous, frequently broken and irregular, more or less concentric bands, 1 to 6 cells in width, often in contact with the pores. It is also of rather sporadic occurrence about the pores, independent of the metatracheal bands. Occasionally cells are isolated among the fibres, or scattered in small groups of 2 to 3. The individual cells, on cross-section, are mostly slightly larger than the fibres, but much thinner-walled.

The longitudinal strands of parenchyma are composed of 4 to 8 (mostly 8) short rather uniform cells, which commonly contain light-brown deposits.

*Rays*.—On cross-section the rays are rather numerous (9 to 12 per millimetre) and mostly one pore's width, or less, apart. They are somewhat wavy, due to bending about the pores. The individual cells are variable from short to distinctly radially elongated, the latter being found especially in the wider rays. The cells commonly contain reddish-brown deposits.

On tangential section the rays are mostly biserrate in whole or part, although frequently uniserrate, and rarely triserrate, in part. They are 1 to 32 cells (0.051 mm. to 0.906 mm.) high, and composed of subcircular to slightly vertically-elongated cells, except for those at the top and bottom of the rays, which are often decidedly elongated.

The rays are heterogeneous on radial section. In the majority the bulk of the cells are slightly elongated radially (procumbent), with one to several rows of square to axially-elongated cells on the margins, but at times the low rays are mostly or entirely composed of upright cells.

*Material*.—Yale Nos. 5174, 5174A, 5174B.

## 7. ELAEOCARPACEAE.

This family, which some botanists include in the Tiliaceae, consists of ten or eleven genera of trees and shrubs of wide distribution in tropical and subtropical regions of the Southern Hemisphere. As a rule the timber and other products produced by the Elaeocarpaceae are of slight commercial importance. *Elaeocarpus*, with two species of timber-trees, represents the family in New Zealand.

Anatomical characteristics are not very constant in the woods of the Elaeocarpaceae. The vessels usually have simple perforations, although occasionally the scalariform type occurs side by side with the former, and spiral thickening of the walls may be present. Simple or narrowly-bordered pits occur in the wood fibres, which are usually thin-walled and frequently septate. Wood parenchyma is generally present, and often abundant. The rays are from one to several cells in breadth, and the pits in contact with the vessels may be simple or half-bordered.

### **Elaeocarpus dentatus** Vahl. HINAU.

Hinau is a medium-sized tree, distributed throughout New Zealand with the exception of the southern part of the South Island. It grows along the sea-coast and on the lower slopes of ridges, up to 3,000 ft. above sea-level. The tough, strong, durable wood is valuable for fresh-water piling, fencing, bridge-construction, house-blocks, rail-road-ties, ship's timbers, vehicle-hubs, and broom and brush stocks. The bark is said to yield a tannin, as well as a good permanent black dye.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light, but fairly hard, easily worked; sp. gr. (air-dry), 0.611; weight, 38.2 lb. per cubic foot (35-39 $\frac{1}{4}$  lb.—Stone). Grain straight; texture fine and even. Colour light brown; lustre dull. Aqueous solution light yellowish-brown. Odour and taste not distinctive.

*Growth-rings.*—Apparent growth-rings faintly discernible with unaided eye; caused by slight decrease in size of pores, or at times by faint difference in colour of early and late wood. True growth-rings visible only with compound microscope; formed by single rows of enlarged wood fibres.

*Parenchyma* invisible without microscope.

*Pores* just visible in part to unaided eye; small to minute, numerous; solitary, or more often in distinct radial groups of 2 to 8 or more; at times decreasing slightly in size toward outside of apparent growth-rings; whitish deposits infrequent.

*Vessel-lines* faintly visible without lens, fine; slightly darker than background.

*Rays* numerous, rather narrow to minute, low; bending somewhat about pores; fairly distinct in part without lens on cross-section; somewhat darker than background and readily visible to unaided eye on radial surface; mostly indistinct without lens in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are numerous and well distributed, occurring singly, or more often in radially-appressed groups of 2 to 10 or more. The individual pores are oval to angular

in shape, mostly in contact with two rays, and 0.022 mm. to 0.127 mm. in tangential diameter. At times they decrease slightly in size toward the outside of the growth-rings. The walls are mostly slightly thinner than those of the fibres. The cavities are open.

The vessel-segments, as seen on longitudinal sections and in macerated material, are mostly rather long and irregular, with short to rather extended projecting tips. The end walls of the segments are usually somewhat oblique, the openings usually slightly oval, and the perforations exclusively simple. Horizontal resin-plates are occasionally present.

The vessel-walls bear distinct frequently-anastomosing spirals. The intervacular pits are distinctly bordered, and have a screw-head appearance, due to the usually horizontal, narrow-lenticular mouths, which extend almost to the borders. Their typical arrangement is alternate, and they are usually so numerous that the otherwise rounded borders assume a polygonal outline. The simple, or occasionally half-bordered, vessel-ray pits are fairly large, rather numerous and at times crowded, irregularly-disposed, and variable in outline.

*Wood Fibres*.—Libriform wood fibres make up only about half of the groundmass of the wood, due to the abundance of the rays and vessels. On cross-section they are mostly inclined to rectangular in shape, and disposed in very definite radial rows, in which they are fairly uniform in size. Growth-rings are produced by single tangential rows of rather thin-walled, enlarged fibres, which have somewhat the appearance of parenchyma cells on cross-section. At times these rings are emphasized by a flattened condition of the fibres adjacent to them. The middle lamella is greenish-yellow in colour, and commonly thickened at the corners.

As seen on longitudinal sections and in macerated material the fibres are short, fairly slender cells, that either taper to long sharp points from near the middle, or more often have slightly enlarged, cylindrical, median portions, with indistinct shoulders, and terminate in short sharp tips. The width of the median portion varies from 0.017 mm. to 0.034 mm., and the length of the fibres from 0.77 mm. to 1.54 mm. The walls are mostly of medium thickness and the lumina fairly wide, especially on tangential section. Faint horizontal resin-plates are occasionally found. The pits are minute and indistinctly bordered, with the vertically-inclined slit-like mouths slightly exceeding the borders in face view. They are mostly confined to the radial walls and distributed throughout the enlarged portions of the fibres.

*Wood Parenchyma*.—Parenchyma is very rarely present as isolated strands among the wood fibres.

*Rays*.—The rays are uniseriate or, less often, multiseriate. On cross-section the former are very numerous (11 to 16 per millimetre, and 1 to 6 rows of fibres apart), while the latter are few in number (1 to 3 per millimetre). All are rather wavy, due to bending about the pores. The individual cells in the broad rays are somewhat radially elongated, while those in the uniseriate ones are usually shortened and more nearly square. Dark-brown deposits and somewhat lighter-coloured polygonal crystals are of frequent occurrence.

On tangential section the predominating uniseriate rays are linear in outline, and 1 to 15 cells high. The irregular broad rays, which

frequently have short to fairly long uniseriate tips, are 0.028 mm. to 0.079 mm. (3 to 5 cells) wide and 0.205 mm. to 0.941 mm. high in the multiseriate portions. The individual cells in the uniseriate portions are mostly square to vertically oblong, while those in the multiseriate portions are small and irregular. The cells at the top and bottom of all the rays are obtusely or acutely pointed.

The rays are heterogeneous on radial section. The cells in the uniseriate rays and on the borders of the multiseriate are distinctly axially elongated (upright), while those in the multiseriate portions are short to much elongated radially (procumbent). Crystals are of very frequent occurrence, especially in the upright cells, which are often subdivided horizontally into 2 to 4 chambers.

*Material*.—Yale Nos. 5135, 5135A.

**Elaeocarpus Hookerianus** Raoul. POKAKA.

Pokaka is a small tree, 30 ft. to 40 ft. in height, with a diameter of 1½ ft. to 2 ft. It is generally distributed throughout New Zealand, although rare in some parts, and grows chiefly at high altitudes. The wood is more limited in its uses than hinau, but finds a demand in mine-props, building studs and joists, shelving, and crating. It also has possibilities as a pulp-wood. The bark yields a tannin.

The wood of *E. Hookerianus* has many features in common with that of *E. dentatus*, but there are a number of outstanding characteristics. The weight of the two woods is about the same, the former having a specific gravity of 0.623 (38.9 lb. per cubic foot), and the colour is quite similar. The grain of the only available specimen of pokaka is rather wavy. The growth-rings are fairly distinct to the unaided eye, and are not emphasized by a decrease in the size of the pores, which are minute and usually indiscernible without a lens, and mostly disosseous in somewhat longer radial lines than in hinau. The rays are very numerous, but, being lighter in colour than in *E. dentatus*, are not as distinct on radial surface, while in tangential view they are indiscernible even with a lens.

In a study of the minute anatomy of pokaka a few distinctive features were noted. The pores are very small to minute (0.019 mm. to 0.084 mm. in tangential diameter), and disposed singly, or more often in radially-appressed groups or lines; in the latter instances they consist either of short groups of 2 to 25 or more pores, or somewhat longer lines of many pores and few fibres. Rather indistinct growth-rings are produced by a slightly flattened condition of the wood fibres at the termination of the late wood. The rays are very numerous (16 to 20 per millimetre on cross-section), and the uniseriate ones are somewhat higher than in the other species (1 to 30 cells on tangential section). On radial section the upright cells in the uniseriate portion of the rays are frequently subdivided horizontally into 2 chambers, each frequently containing a single greenish-brown polygonal crystal. The vessels apparently do not contain horizontal resin-plates. The other measurements recorded are as follows: Length of wood fibres, 0.56 mm. to 1.25 mm.; width of wood fibres, 0.014 mm. to 0.028 mm.; height of multiseriate portions of wide rays, 0.12 mm. to 1.57 mm.; width of multiseriate rays (2 to 6 cells), 0.026 mm. to 0.077 mm.

*Material*.—Yale No. 5169.

## 8. MALVACEAE.

The mallow family consists of about forty-five genera and upward of one thousand species of herbs, shrubs, and a few trees, of extensive distribution. Some of the herbs and shrubs are valuable for decorative planting, while the trees, as a rule, are more useful for their fibrous bark than for their timber. It is to this family that the cotton-plant (*Gossypium*) belongs. Two genera, *Hoheria* and *Plagianthus*, each with a single arborescent species, represent the Malvaceae in New Zealand.

The vessels are characterized by simple perforations and, in certain genera, by spiral thickenings. The wood fibres are thick- or thin-walled, with simple or indistinctly bordered pits. Abundant wood parenchyma is sometimes present. The 1-9-seriate rays bear simple or half-bordered pits in contact with the vascular elements.

**Plagianthus betulinus** A. Cunn., or **Hoheria populnea** A. Cunn.  
LACEBARK.

The source of the only available specimen of lacebark is not definitely known. However, it undoubtedly belongs to the Malvaceae, and, inasmuch as there are but two arborescent species of this family in New Zealand, it must be the product of either *Plagianthus betulinus* or *Hoheria populnea*.

*Plagianthus betulinus*, known locally as houi, manatu, powhiwhi, whauai (Marlborough), and ribbonwood (Wellington), occurs rather sparsely throughout New Zealand, from sea-level to 3,000 ft. elevation. It sometimes attains a height of 35 ft. to 40 ft. in its best development. The wood is of little commercial value, although a small quantity is used for cabinet-work, inlaying, and panelling, and it is said to have possibilities as a pulp-wood. The bark is used by the Natives in the manufacture of mats, baskets, &c.

*Hoheria populnea*, otherwise known as ribbonwood, houhere, powhiwhi, whauwhi (Auckland), and thousand-jacket (Auckland), is scattered throughout both the North and South Islands, mostly on river-flats and banks. The wood is not used, although it should be suitable for paper-making.

## MACROSCOPIC FEATURES.

*General Properties*.—Wood rather soft and of medium weight; easily worked, but tough; sp. gr. (air-dry), 0.703; weight, 43.9 lb. per cubic foot. Grain straight; texture rather fine. Colour dingy grey to light brown; abundantly marked with light-coloured parenchyma; lustre dull. Solution colourless. Odour and taste not distinctive.

*Growth-rings*.—Apparent growth-rings produced by decrease in width of denser fibrous zones, and resultant diminution in distance between tangential bands of pores and parenchyma; more distinct to unaided eye than with lens or microscope; rather wide.

*Parenchyma* abundantly developed and prominent on all sections; on cross-section distinct to unaided eye as very close, narrow to fairly wide, concentric bands, which embrace the pores and are more or less concave between wide rays; on radial surface appearing as

numerous, slightly wavy, parallel lines; in tangential view occurring as white patches, sharply contrasted to the light-brown fibrous groundmass.

*Pores* invisible without lens, small to minute; distinctly ring-porous in arrangement, being confined to rather narrow bands and embedded in parenchyma; fairly numerous; single or frequently crowded in irregular groups; open.

*Vessel-lines* barely visible with lens as minute scratches in the bands of parenchyma; same colour as background.

*Rays* rather few, narrow to wide, low to fairly high, white; broad rays very distinct to unaided eye on cross-section; readily visible on radial section, producing somewhat prominent silver grain; discernible without lens in tangential view.

*Ripple marks* very faint horizontal lines, visible with lens on longitudinal sections; 80 to 92 per inch; caused by seriation of parenchyma strands and vessels.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are in distinct ring-porous arrangement, being embedded in narrow to rather wide tangential bands of parenchyma. They are fairly numerous, and solitary or in irregular groups of 2 to 25 or more. The individual pores are very irregular and angular in outline, and vary in tangential diameter from 0.034 mm. to 0.105 mm. The walls are much thinner than those of the fibres; about the width of the parenchyma walls. The lumina are open.

The vessel-segments are mostly quite uniform, being short and cylindrical, and are in distinct horizontal seriation with the adjoining segments and parenchyma strands. The end walls of the segments vary from horizontal to slightly oblique, the openings are round to oval, and the perforations are exclusively simple.

The vessel-walls are marked with prominent rather coarse spirals. The intervesselular pits are distinctly bordered, and have a screw-head appearance. They are small, usually numerous, and at times so crowded that their round to horizontally-oval border assumes a rather rectangular form. Their typical arrangement is opposite, although at times they appear somewhat spirally disposed. The horizontally-inclined mouths extend almost to the borders. The vessel-ray pits are simple, or seldom very indistinctly bordered, with one pit in a ray covering several in a vessel. They are fairly numerous, small to rather large, horizontally oval to lenticular in outline, and somewhat opposite in disposition.

*Wood Fibres*.—Libriform wood fibres make up only about half the groundmass of the wood, being confined to irregular zones between the bands of parenchyma and vessels. On cross-section they are polygonal in outline, and exhibit a tendency to be disposed in radial rows, in which there is considerable variation in the size of the fibres. Very frequently the cells have double walls, the outer polygonal one being reinforced by a rounded mucilaginous layer.

As seen on longitudinal sections and in macerated material the fibres are rather long, slender cells, usually tapering gradually to very extended sharp-pointed tips. They are 0.011 mm. to 0.027 mm. wide in the median portion, and 1.18 mm. to 1.92 mm. long. The

walls are very thick, and the lumina accordingly narrow. The pits are fairly numerous, very small, and indistinctly bordered with narrow, slit-like, vertically-inclined mouths, which exceed the borders. They occur in both radial and tangential walls.

*Wood Parenchyma*.—The parenchyma is abundantly developed in rather wide, close, tangential bands, which embrace the vessels and are often as wide as the intervening fibrous zones. These bands are inclined to be somewhat concave between the broad rays. The parenchyma also occurs rather frequently as isolated cells, or small groups of cells, scattered among the wood fibres. The individual cells, as viewed on cross-section, are mostly larger than the fibres and much thinner-walled, and in the terminal bands are usually disposed in fairly definite radial rows.

The longitudinal strands of parenchyma are composed of 2, or rarely 3 or 4 cells, and are considerably wider than the fibres, and quite regular in shape. They are in distinct horizontal seriation with the vessel-segments, and usually exhibit somewhat irregular secondary seriation among themselves.

*Rays*.—The rays are of two distinct sizes. On cross-section the broad rays are rather few (1 to 4 per millimetre), fairly regularly disposed, and somewhat irregular in shape, due to a tendency to enlarge upon passing through the bands of terminal parenchyma. The uniseriate rays are few, inconspicuous, and sporadic in occurrence. The individual cells are very narrow, and considerably elongated radially, except in the uniseriate rays and on the borders of the multiseriate, where they are considerably shorter and wider.

On tangential section the uniseriate rays are rather inconspicuous, and composed of 1 to 8 cells, which are circular in outline in the bands of parenchyma, but among the wood fibres are narrow and somewhat vertically elongated. The multiseriate rays are very prominent, and 2 to many cells (0.026 mm. to 0.26 mm.) wide and 7 to many cells (0.10 mm. to 1.76 mm.) high. The interior cells are small and irregular in outline, while those on the borders are larger and mostly axially elongated.

The rays are heterogeneous on radial section. The cells in the uniseriate rays and on the borders of the multiseriate are square to vertically elongated (upright), while those in the interior of the broad rays are very low and considerably elongated radially (procumbent).

*Material*.—Yale No. 5160.

#### 9. MYRTACEAE.

The myrtle family consists of over seventy genera and about 2,800 species of trees and shrubs, widely distributed throughout the tropical and subtropical regions of the world. The most important genus of the family, from the standpoint of timber-production, is the *Eucalyptus*, which makes up the bulk of the Australian forests. The Myrtaceae is abundantly represented in New Zealand by four timber-producing genera—*Myrtus* (4 species), *Metrosideros* (3 species), *Leptospermum* (2 species), and *Eugenia* (1 species).

The wood is characterized by vessels with simple or scalariform perforations and usually half-bordered vessel-ray pits. Bordered pits occur in the thick-walled fibres. The wood parenchyma is sparsely or abundantly developed. The rays are 1-3 cells in width.

**Metrosideros lucida** A. Rich. SOUTHERN RATA, RATA, IRONWOOD (Westland), NEW ZEALAND IRONWOOD (Otago).

— Southern rata occurs mainly in South Island, from sea-level to the grass-line (3,500 ft. elevation). It grows along the coast, on the shores of lakes, and on high dry ranges and cliffs, attaining a height of 100 ft. in its best development. The strong, hard, durable wood is in demand for bridge and wharf construction, ship and coach building, machine bed-plates, cog-teeth, and rollers, railroad-ties, cross-arms, fencing, bullock-yokes, wheelwright's work, axe- pick- and tool-handles, and hockey-sticks.

MACROSCOPIC FEATURES.

*General Properties.*—Wood extremely hard and heavy, difficult to work; sp. gr. (air-dry), 1.186 to 1.210; weight, 74.1 lb. to 75.6 lb. per cubic foot (63-71½ lb.—Stone). Grain straight; texture fine and even. Colour rather dark brown, with slight purplish caste; lustre rather dull. Aqueous solution light reddish-brown. Odour and taste not distinctive.

*Growth-rings* invisible without compound microscope; formed by flattening of the fibres at the termination of the late wood.

*Parenchyma* present, but indiscernible without microscope.

*Pores* small to minute; those containing white deposits readily apparent to unaided eye, others barely visible in part without lens; fairly numerous and well distributed, solitary; mostly filled with white deposits.

*Vessel-lines* fairly distinct to unaided eye, narrow; white against dark background when filled with deposits.

*Rays* numerous, minute, low; invisible without lens on cross-section; somewhat darker than background and distinct to unaided eye on radial surface; just visible in tangential view.

MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are fairly numerous, solitary, and well distributed. They are oval to angular in outline, with the longest axis radial, and vary in tangential diameter from 0.023 mm. to 0.147 mm. The walls are slightly thinner than those of the fibres. The lumina are frequently filled with dark, reddish-brown deposits.

The vessel-segments are short to fairly long, and rather irregular in shape, with brief, narrow, projecting tips. The end walls of the segments are horizontal to rather oblique, the openings round to oval, and the perforations exclusively simple.

Pits are the sole markings on the vessel-walls. Those between vessels are fairly numerous, small, and rather irregularly disposed, or often in more or less vertical rows. The borders are circular in outline, and the mouths minute and dot-like. The often indistinctly half-bordered vessel-ray pits are usually slightly larger than the intervascular ones, and mostly slightly elongated, frequently in a vertical direction.

*Wood Fibres.*—Libriform wood fibres make up the groundmass of the wood. On cross-section they are somewhat rounded to polygonal in outline, and disposed either irregularly or in fairly distinct radial rows. Rather indistinct growth-rings are produced by a flattened

condition of the fibres at the termination of the late wood. The middle lamella is yellowish in colour and conspicuously thickened at the corners. Very often the normal fibre walls of ligno-cellulose are thickened with distinct mucilaginous layers.

As seen on longitudinal sections and in macerated material the fibres are short, slender, irregular cells, usually tapering from near the middle. They are 0.014 mm. to 0.028 mm. wide in the median portion, and 0.442 mm. to 1.454 mm. long. The walls are very thick, and the lumina correspondingly narrow. The pits, in face view, are rather small and distinctly bordered, with narrow-lenticular vertically-inclined mouths extending almost to the circular borders. They occur in both radial and tangential walls, and are usually distributed throughout the entire length of the fibres.

*Wood Parenchyma.*—On cross-section the parenchyma appears rather sparsely developed, occurring (1) as isolated cells or small groups of cells scattered among the wood fibres (diffuse), and (2) as short to fairly long, irregular, broken, tangential lines, rarely more than one cell in width (metatracheal). The individual cells are about the same size as the wood fibres, but very much thinner-walled. The longitudinal strands of parenchyma are composed of 2 to 4 cells, which are practically all filled with reddish-brown to black deposits.

*Rays.*—On cross-section the rays are very numerous (11 to 19 per millimetre) and rather wavy, due to bending about the pores. The individual cells are radially elongated, especially in the broader rays, and are practically all filled with reddish-brown to black deposits.

On tangential section the rays are mostly uniserial, although frequently biserial and triserial. The uniserial are 1 to 20 cells (0.034 to 0.889 mm.) high. The broader rays, which usually have short to very long uniserial tips, have a total height of 0.159 mm. to 1.197 mm.; the multiseriate portions are 4 to 18 cells (0.120 mm. to 0.427 mm.) high. The individual cells in the uniserial portions of the rays are rather large and distinctly axially elongated, while those in the multiseriate portions are smaller and subcircular in outline.

The rays are heterogeneous on radial section. The cells in the uniserial rays and on the margins of the broad rays are rather large, and mostly square to axially elongated. Those on the multiseriate portions of the rays are low and radially elongated.

*Material.*—Yale Nos. 5147, 5148, 5148A, 5148B, 5148C.

#### ***Metrosideros robusta* A. Cunn. NORTHERN RATA, RATA.**

The northern rata is confined mostly to the North Island and the northern part of the South Island. It grows as a large tree from sea-level to 2,000 ft. in elevation, but is dwarfed between that and the grass-line (3,500 ft.). The wood is used for practically the same purposes as the southern rata.

The wood very closely resembles that of the southern species, having no outstanding differences. It is rather pale chocolate-brown in colour, being somewhat lighter than *M. lucida* and lacking its purplish tinge, and the growth-rings are at times vaguely indicated on cross-section by rather indistinct differences in the colour of the apparent early and late wood. There are no distinctive microscopic differences between the wood of the two species.

The following measurements were recorded for *M. robusta*: Diameter of vessels (pores), 0.017 mm. to 0.142 mm.; length of wood fibres, 0.616 mm. to 1.539 mm.; width of median portion of wood fibres, 0.014 mm. to 0.031 mm.; number of rays per millimetre (cross-section), 12 to 17; height of uniseriate rays (1-28 cells), 0.034 mm. to 1.043 mm.; height of entire multiseriate rays, 0.137 mm. to 0.941 mm.; height of multiseriate portion of multiseriate rays (6-27 cells), 0.137 mm. to 0.598 mm.; sp. gr. (air-dry), 1.137; weight per cubic foot, 71.1 lb. (61 $\frac{1}{4}$  lb.—Stone).

Material.—Yale No. 5166.

**Leptospermum scoparium** Forst. MANUKA, KAHIKATOA, WHITE TEA-TREE.

Manuka is a small tree, attaining a height of but 20 ft. It is found throughout New Zealand, principally on the lowlands, although it may occur at elevations of 3,000 ft. The wood is used in the manufacture of tool-handles and furniture, as well as for fencing, piling, canoe-poles, sheep-hurdles, and stakes.

Three varieties of the wood are recognized in Wellington — red (kahikatoa), white (kapuka), and pale (kaikaia).

MACROSCOPIC FEATURES.

*General Properties*.—Wood hard and heavy; sp. gr. (air-dry), 0.893 to 0.904; weight, 55.8 lb. to 56.5 lb. per cubic foot. Grain straight; texture fine and even. Colour medium brown, with slight reddish tinge, when freshly cut; darkening upon exposure to rich chocolate-brown; lustre dull. Aqueous solution distinct reddish-brown. Odour and taste not distinctive.

*Growth-rings*.—Apparent growth-rings readily visible to unaided eye as rather irregular dark bands; formed by dense, practically poreless zones of wood. True growth-rings formed within poreless zones by flattened condition of fibres; visible only with compound microscope.

*Parenchyma* indiscernible without microscope.

*Pores* mostly just visible to unaided eye, small to minute; fairly numerous, but practically confined to broad zones of early wood; solitary, or rarely in radial groups of 2; open.

*Vessel-lines* fairly distinct without lens, fine; slightly darker than background.

*Rays* numerous, narrow to minute, low; invisible without lens on cross and tangential sections; slightly darker than background and fairly distinct to unaided eye on radial surface.

MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are fairly numerous, and mostly confined to the rather broad zones of early wood. They are single, or occasionally crowded together in groups of 2, or rarely 3. The solitary pores are usually inclined to oval, with the longest axis radial, and are in contact with 1 to 3, mostly 2, rays. They vary in tangential diameter from 0.031 mm. to 0.153 mm. The walls are mostly about as thick as those of the fibres. The cavities occasionally contain yellowish-brown deposits.

The vessel-segments as seen in macerated material and on longitudinal sections are mostly rather short and cylindrical in shape, and commonly have brief projecting tips. The end walls are horizontal to slightly oblique, the openings usually round, and the perforations exclusively simple.

Pits are the sole markings on the vessel-walls. Those between vessels are minute and rather indistinct, with rounded borders and dot-like mouths. They are rather numerous, but not crowded, and mostly somewhat spirally or irregularly disposed. The half-bordered vessel-ray pits are identical in appearance with the intervacular.

*Wood Fibres*.—Libriform wood fibres make up the groundmass of the wood. On cross-section they are rather irregularly polygonal in outline, and exhibit a tendency to be disposed in radial rows, especially in the poreless late wood. Rather indistinct growth-rings are produced in the denser zones by a decided flattening of the fibres terminating the late wood. The yellowish middle lamella is frequently thickened at the corners.

As seen on longitudinal sections and in macerated material the fibres are short, slender, irregular cells, tapering to sharp points from near the middle. They are from 0.547 mm. to 1.197 mm. long, and the width of the median portion varies from 0.013 mm. to 0.031 mm. The walls are thick, and the lumina narrow. The pits are large, numerous, and distinctly bordered, with circular borders and minute mouths in face view. They occur in both radial and tangential walls, and are well distributed throughout the entire length of the fibres.

*Wood Parenchyma*.—The parenchyma is of three types—paratracheal, metatracheal, and diffuse. The paratracheal is rather sporadic in occurrence, and 1, or rarely 2, cells wide. The metatracheal appears as very irregular broken lines, 1, or occasionally 2, cells in width, and confined to the regions of the pores. The diffuse is present as isolated cells, or short groups of cells, which in the more open zones are closely linked up with the metatracheal parenchyma. On cross-section the individual cells are of about the same size as the fibres, but are much thinner-walled. The cavities very often contain dark reddish-brown to black deposits.

The longitudinal strands of parenchyma are composed of 2 to 4, usually 4, cells, and are about as wide as the fibres. They are frequently enlarged and chambered, containing 4 to 8 large irregular crystals, which are quite distinct on all sections.

*Rays*.—On cross-section the rays are very numerous (10 to 17 per millimetre), often less than a pore's width apart, and somewhat wavy, due to bending about the pores. The individual cells are very narrow and considerably radially elongated in the multiseriate rays, but in the uniseriate they are much shorter and more irregular in shape. Dark reddish-brown deposits completely fill most of the cells.

On tangential section the rays are 1 to 3 cells wide (occasionally 4 in part). The uniseriate are 1 to 30 cells (0.034 mm. to 0.958 mm.) high, while the broad ones, which usually have short to fairly long uniseriate tips at one or both ends, are 6 to 50 cells (0.128 mm. to 1.077 mm.) high in the multiseriate portions. The individual cells are rather small and slightly elongated vertically in the uniseriate

portions of the rays, while in the multiseriate portions they are very small and subcircular in outline. The cells at the margins of all rays are rather obtusely pointed.

The rays are heterogeneous on radial section. The uniseriate portions are largely composed of cells which are square to slightly axially elongated, while the multiseriate portions are made up of very low cells, which are considerably elongated vertically.

*Material*.—Yale No. 5175.

#### 10. EPACRIDACEAE.

This family consists of twenty-one genera and upwards of 340 species, confined mainly to Australia and Polynesia. A single genus of importance, *Dracophyllum*, occurs in New Zealand, being represented by three arborescent species.

The vessels may have exclusively simple or scalariform, or both simple and scalariform, perforations. Bordered pits occur in the walls of the wood fibres. The wood parenchyma is usually little developed. The rays are mostly 1-2-seriate, although they may be as many as 13 cells in width in certain genera.

#### ***Dracophyllum latifolium* A. Cunn. NEINEI, SPIDERWOOD (Auckland).**

Neinei is a small tree, distributed along the coast and on the mountain-sides throughout the North Island and the northern part of the South Island. The wood is tough and elastic, but, because of its small size, is limited in its uses to canes, wheelwright's work, tool-handles, and fencing.

#### MACROSCOPIC FEATURES.

*General Properties*.—Wood moderately hard and heavy, easily worked; sp. gr. (air-dry), 0.742; weight, 46.2 lb. per cubic foot. Grain straight; texture fine and even. Colour light brown, usually with pale pinkish tinge; lustre dull. Aqueous solution faint light brown. Odour and taste not distinctive.

*Growth-rings* fairly distinct to unaided eye, close; somewhat depressed in contact with large rays; formed by slight difference in density of early and late wood.

*Parenchyma* present, but invisible without microscope.

*Pores* barely discernible even with lens; minute, numerous; more abundant in early wood; open.

*Vessel-lines* scarcely distinguishable with lens, minute; about the same colour as background.

*Rays* of two distinct sizes. Large rays few; mostly rather wide; low to very high; conspicuous on all sections; on transverse section radiating out from pith in distinct spider-leg fashion (hence the name "spiderwood"); on radial surface somewhat darker than background, usually with distinct pinkish tinge, producing conspicuous silver grain. Small rays extremely numerous, exceedingly narrow, low; barely visible with lens on cross-section; slightly darker than background and rather faintly discernible with unaided eye on radial surface; indistinct even with lens in tangential view.

## MICROSCOPIC FEATURES.

*Vessels.*—On cross-section the vessels (pores) are very numerous, solitary or frequently in small, mostly tangentially-appressed groups of 2, or rarely more, and rather irregularly disposed. Under low power they are found to be mostly confined to the rather wide bands of early wood, and in some cases exhibit a rather indistinct tendency to be arranged in broken tangential lines, beginning the growth-rings. The individual pores are very irregular and angular in outline, and vary in tangential diameter from 0.014 mm. to 0.042 mm., usually being but slightly larger than the fibres. The walls are very thin. The cavities are open.

The vessel-segments are mostly rather long, and have short tongue-like projecting tips. The end walls of the segments are very oblique, the openings elongated-elliptical, and the perforations exclusively scalariform, with 14 to 45 close and rather uniform bars. Horizontal resin-plates are occasionally present.

The vessel-walls are marked with spiral striations. The indistinctly-bordered intervacular pits, and the apparently simple vessel-ray pits, are mostly small and horizontally elongated, frequently being distinctly scalariform.

*Wood Fibres.*—Libriform wood fibres make up only about half of the groundmass of the wood, due to the preponderance of rays and vessels. On cross-section they are largely inclined to quadrangular in outline, and are disposed in very distinct radial rows. The size is fairly constant throughout a given row, although those cells at the termination of the growth-rings are distinctly flattened and have correspondingly smaller lumina. The middle lamella is greenish in colour, and frequently somewhat thickened at the corners. The lumina are open.

As seen on longitudinal sections and in macerated material the fibres are short, slender, rather uniform cells, mostly tapering gradually from near the middle. They are 0.010 mm. to 0.028 mm. wide in the median portions, and vary in length from 0.547 mm. to 1.214 mm. The walls are mostly rather thick, and the lumina usually narrow. The fibres are often falsely septate by means of horizontal resin-plates. The pits are distinctly bordered, with vertically-inclined, narrow-lenticular mouths extending to the circular borders in face view. They are small, fairly numerous, and disposed throughout the entire length of the fibres, occurring in both radial and tangential walls.

*Wood Parenchyma.*—The parenchyma is very sparsely developed, occurring as isolated cells, or small groups of cells, scattered among the wood fibres. The longitudinal strands are made up of 2 cells, which are much elongated and about as wide as the fibres.

*Rays.*—The rays are of two very distinct sizes. The broad ones are few in number, and on cross-section are composed of cells which usually tend toward square, although they are frequently slightly elongated, either radially or tangentially. The uniseriate rays are very numerous (18 to 22 per millimetre), and 1 to 4 or more rows of fibres apart. They are rather straight, and made up of cells which are mostly slightly elongated radially. The cells in all the rays are often partly or entirely filled with dark-brown deposits.

On tangential section the multiserial rays are 8 to 13 cells (0.137 mm. to 0.342 mm.) wide in the median portion, and vary in height from 1.539 mm. to 31.85 mm. The individual cells are mostly subcircular, although those in the exterior row are often slightly elongated vertically. Not infrequently the broad rays terminate in very short uniserial tips, made up of one to several distinctly elongated cells. The uniserial rays are 1 to 20, mostly 1 to 8, cells (0.051 mm. to 1.471 mm.) high, and are composed of distinctly vertically-elongated cells. Those cells at the top and bottom of all the rays are inclined to be rather obtusely pointed.

The rays are heterogeneous on radial section. The broad ones are composed of cells which are variable from slightly radially elongated to square or briefly vertically elongated. The marginal cells, however, are all distinctly upright. The uniserial rays are made up of cells which are axially elongated.

Material.—Yale No. 5177.

### II. OLEACEAE.

The olive family consists of twenty-five genera and about 390 species of shrubs or trees, widely distributed in temperate and tropical regions, chiefly in the Northern Hemisphere. To this family belong such garden-plants as the lilacs, forsythias, privets, and jasmines, and such well-known trees as the olive and the ash. But two arborescent species occur in New Zealand, both belonging to the genus *Olea*.

The wood is characterized by vessels with simple, or rarely scalariform, perforations, and half-bordered pits in contact with the 1-4-seriate rays. Spiral thickenings may occur. The wood fibres have simple or bordered pits, and in certain genera bear septa and spirals. The wood parenchyma is usually scantily developed.

**Olea** sp. prob. *lanceolata* Hook. f.\* MAIRE, WHITE-MAIRE.

Maire is a large tree, found scatteringly in the northern and western parts of North Island. The heavy, strong, durable wood is used in house-construction, and for mine-timbers, fence-posts, treenails, croquet mallets and balls, and machine bed-plates and cog-teeth. It is also in demand for all classes of bearings, especially the larger ones, such as the tail-shaft bearings of vessels. Other uses of the wood are ornamental cabinet-work, turnery, and inlaying.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood very hard and heavy, difficult to work; sp. gr. (air-dry), 1.180; weight, 73.7 lb. per cubic foot. Grain straight to slightly wavy, texture fine and even. Colour light brown, irregularly streaked with black. Lustre dull. Aqueous solution practically colourless. Odour not distinctive; taste rather astringent.

*Growth-rings* distinct to unaided eye as close, fine, light, uniform, concentric lines; formed by bands of terminal parenchyma.

*Parenchyma* visible only as terminal lines, marking the growth-rings.

\* The specimen studied agrees in macroscopic structure with Stone's description of *O. lanceolata*, except for the dry weight, which he records as 53 lb. per cubic foot.

*Pores* individually indiscernible without lens, small to minute, fairly numerous, disposed in more or less radial lines or patches, solitary or at times crowded; to unaided eye appear, together with cells, which microscope shows to be tracheids, as distinct, light-coloured, wavy, often anastomozing, radially-inclined lines.

*Vessel-lines* barely distinguishable with naked eye, minute; about same colour as background.

*Rays* fairly numerous, narrow to minute; very low; practically indistinct without lens on cross-section; slightly darker than background, and fairly visible to unaided eye on radial surface; barely discernible with lens in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are fairly numerous, and disposed either singly, or more often in irregular, usually zigzag, often branching, radial or diagonal lines, or patches. The individual pores are subcircular to angular in outline, and vary in tangential diameter from 0.028 mm. to 0.108 mm. The walls are mostly about as thick as those of the fibres. The cavities occasionally contain light-brown to reddish deposits.

The vessel-segments are usually rather short and somewhat irregular, with projecting tips, which are visible in macerated material. The end walls of the segments are slightly to very oblique, the openings oval in outline, and the perforations exclusively simple.

The vessel-walls bear irregular, often anastomozing, spirals. The intervacular pits are fairly small, rather numerous, and irregularly or alternately disposed. The usually rounded borders are sometimes angular, due to crowding. The mouths are minute and dot-like. The half-bordered vessel-ray pits are similar to those between vessels, except that they are inclined to be somewhat smaller and more numerous.

*Tracheids*.—Tracheids are rather abundant, but are practically confined to the region of the pores. They closely resemble wood fibres on cross-section, being thick-walled and about the same size as the fibres, but have more numerous bordered pits and somewhat wider lumina, which are often rather irregular because of spiral markings on the walls. On longitudinal sections they have the appearance of small vessels, being about the same length as the vessel-segments and bearing distinct irregular spirals. The bordered pits are somewhat crowded and possess very small, often slightly vertically-elongated, mouths.

*Wood Fibres*.—Libriform wood fibres make up the groundmass of the wood. On cross-section they are polygonal in outline, and tend to be disposed in more or less definite radial rows. Narrow to rather wide mucilaginous layers are often discernible. The minute cavities, which are mostly rather irregular, frequently contain yellowish to practically colourless deposits.

As seen on longitudinal sections and in macerated material the fibres are short, slender, rather irregular cells, usually tapering to long sharp points from near the middle. They are 0.011 mm. to 0.033 mm. wide in the median portion, and vary in length from 0.652 mm. to 1.456 mm. The walls are very thick, and the lumina correspondingly minute. The pits, which are mostly confined to the radial walls, are somewhat obscure, indistinctly bordered, small and rather few.

*Wood Parenchyma*.—The parenchyma is rather sparsely developed, occurring mainly as fine uniform concentric bands, 1 to 3 cells in width, terminating the growth-rings. Occasional isolated cells occur about the pores. The individual cells are about the same size as the wood fibres, but are much thinner-walled. The longitudinal strands are composed of 2 to 4 cells, normally containing light-brown deposits.

*Rays*.—On cross-section the rays are fairly numerous (5 to 9 per millimetre) and well distributed. They are somewhat irregular when in contact with the pores, and exhibit a tendency to enlarge when passing through the terminal parenchyma. The individual cells are mostly considerably elongated radially, especially in the wider rays, and commonly contain brownish deposits.

On tangential section the rays are narrow-lenticular in outline, and mostly biserrate (in whole or part), although frequently uniserrate and rarely triserrate in part. They are 1 to 24 cells (0.017 mm. to 0.445 mm.) high, and composed of comparatively thick-walled cells, which are usually suboval, with the longest axis vertical. The cells at the top and bottom of the rays are acutely or obtusely pointed, and often somewhat enlarged.

The rays are heterogeneous, or more often homogeneous, on radial section. The great bulk of the cells are low and radially elongated, but those at the margins are commonly shorter and higher, and in some cases distinctly upright.

*Material*.—Yale No. 5167.

## 12. VERBENACEAE.

The teak family consists of about seventy-five genera and one thousand three hundred species, mostly herbaceous plants, and is of wide distribution in both temperate and tropical regions. Some of the species are important trees, among them the teak of the Asiatic tropics and some of the species of *Vitex*. *Vitex lucens* is the sole timber-tree of the family native to New Zealand.

The vessel-perforations are predominately simple, although those of the scalariform type are rarely found accompanying them. The wood fibres bear simple pits and are sometimes septate. The wood parenchyma is usually sparsely developed. The rays are 1-6-seriate, and exhibit distinctly bordered, or both simple and bordered, pits in contact with the vessels.

### ***Vitex lucens* T. Kirk. PURIRI, NEW ZEALAND TEAK.**

Puriri is a coastal tree, confined in its distribution to the northern half of the North Island. The wood is very durable, and valuable for fresh- and salt-water piling, fence-posts, foundation-sills, house-blocks, railroad-ties, and treenails. It is also used for house and car framing, bed-plates, bearings, tackle-blocks, bridge-stringers, furniture, cabinet-work, and veneers.

#### MACROSCOPIC FEATURES.

*General Properties*.—Wood very hard, heavy, tough, and strong; rather difficult to work; sp. gr. (air-dry), 1.024; weight, 64 lb. per cubic foot. Grain fairly straight to somewhat interwoven; texture

very fine and even. Colour light chestnut to chocolate-brown, becoming somewhat tinged with green upon exposure; slightly lustrous on radial surface. Aqueous solution light green. Odour not distinctive, but at times suggestive of silage; taste slightly astringent.

*Growth-rings* indistinct to unaided eye, although occasionally indicated by demarcation between lighter and darker zones of wood; visible with lens as rather faint, fine concentric lines; formed by difference in size and shape of wood fibres.

*Parenchyma* present, but indiscernible without microscope.

*Pores* barely visible in part without lens, small to minute; rather numerous; fairly regularly distributed; solitary, or more often in usually radial groups of 2 to 5; frequently contain lustrous tyloses, and occasionally white deposits.

*Vessel-lines* fairly distinct to unaided eye, fine; darker than background.

*Rays* fairly numerous, narrow to minute, low; barely discernible to unaided eye on cross-section; slightly darker than background and fairly distinct without lens on radial surface; scarcely visible with lens in tangential view.

#### MICROSCOPIC FEATURES.

*Vessels*.—On cross-section the vessels (pores) are fairly numerous and irregularly disposed, occurring singly or more often in small, mostly radially-appressed groups of 2 to 5. The solitary pores are round, oval, or angular in outline, and vary in tangential diameter from 0.042 mm. to 0.198 mm. The pore-walls are about as thick as those of the fibres. The lumina are occasionally filled with brownish deposits.

Pitted tyloses are of frequent occurrence. In all but the larger vessels they are rather regularly cylindrical in shape, conforming to the sides of the vessels, and possessing horizontal end walls, which resemble resin-plates. The pitted condition is at times apparent on cross-section, the pits resembling those in the end walls of parenchyma-cells.

The vessel-segments are short to rather long and irregular in shape, and frequently have projecting tips on the ends. The end walls vary from practically horizontal to rather oblique, the openings are round to oval, and the perforations are exclusively simple.

Fine, close, spiral striations are at times visible in the vessel-walls. The small, distinctly bordered, intervacular pits are usually very numerous, and often so crowded that the otherwise rounded border assumes a polygonal outline. They are mostly alternate and spiral in arrangement. The pit-mouths are dot-like or slightly horizontally elongated. The simple or indistinctly bordered vessel-ray pits are variable from small to fairly large, and are rather irregular in shape and disposition, although usually horizontally elongated and opposite.

*Wood Fibres*.—Libriform wood fibres make up the groundmass of the wood. On cross-section they are polygonal in outline, and exhibit a tendency to be disposed in radial rows, in which they are fairly constant in size. Growth-rings are produced by the contrast between somewhat thinner-walled fibres, with large lumina, at the beginning of the early wood, and slightly flattened cells at the termination of the late wood. Transverse resin-plates quite frequently appear as light-brown deposits.

As seen on longitudinal sections and in macerated material the fibres are short, rather slender, somewhat irregular cells, either tapering gradually to sharp points from near the centre or having an enlarged cylindrical portion, with or without abrupt shoulders. Their length varies from 0.684 mm. to 1.625 mm., and the width of the central portion from 0.019 mm. to 0.043 mm. They are frequently falsely septate by means of horizontal resin-plates. The walls are rather thick and the lumina fairly wide in the enlarged part. The pits are very small, numerous, and simple or very indistinctly bordered, and are mostly confined to the radial walls and distributed throughout the fibres.

*Wood Parenchyma*.—The parenchyma is very sparsely developed, occurring sporadically about the pores as flattened cells (paratracheal), and occasionally scattered throughout the groundmass (diffuse). The individual parenchyma-cells are about the same size as, or slightly larger than, the wood fibres, but much thinner-walled. The longitudinal strands are composed of 2 to 4 cells.

*Rays*.—On cross-section the rays are fairly numerous (4 to 7 per millimetre), usually somewhat more than a pore's width apart, and slightly wavy, due to bending about the pores with which they come into contact. The individual cells are radially elongated, although in the uniseriate rays they are inclined to be somewhat shortened.

On tangential section the rays are mostly biserrate, although frequently uniseriate and occasionally triseriate in part. The uniseriate rays are 1 to 11 cells (0.051 mm. to 0.376 mm.) in height, the multiseriate 5 to 51 cells (0.188 mm. to 1.216 mm.) high. The individual cells are small and usually round or oval, except for the somewhat larger obtusely-pointed ones at the margins.

The rays are predominately heterogeneous on radial section, although occasional homogeneous rays are found. In some instances the heterogeneous rays are entirely composed of square to axially-elongated cells, but more often only the marginal cells are upright. The homogeneous rays are made up of radially-elongated cells, although those at the margins are somewhat shortened.

*Material*.—Yale No. 5165.

### 13. TAXACEAE.

The yew family consists of ten genera and about one hundred and forty species of trees and shrubs, found in the temperate and tropical regions of both hemispheres. In New Zealand it is the main timber-producing family, being represented by three genera—*Podocarpus* (five species), *Dacrydium* (five species), and *Phyllocladus* (three species.)

The woods of the Taxaceae are made up mostly or entirely of tracheids and uniseriate rays, and are often not very distinct from those of the Pinaceae. Resin-ducts, both normal and traumatic, are entirely lacking, as are ray tracheids. Resin-cells (wood parenchyma) may be abundant, rare, or absent. In three genera, *Taxus*, *Torreya*, and *Cephalotaxus*, the tracheid walls bear spirals.

#### ***Podocarpus totara* G. Benn. TOTARA, NEW ZEALAND YEW.**

Totara occurs in both the North and the South Island, but is more plentiful in the former. It grows on the lower flats and the slopes of ridges up to elevations of 3,000 ft. to 3,500 ft., preferring volcanic

soil and moist alluvial situations, and attains a height of 80 ft. to 90 ft., with a diameter of 8 ft. The wood is durable, and much in demand for house, bridge, and wharf construction, poles, railroad-ties, paving-blocks, and wood-pipe staves. It is also used for cooperage, furniture, veneers, interior finish, and cabinet-work.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light and soft, easily worked; sp. gr. (air-dry), 0.577; weight, 36.1 lb. per cubic foot (28-37 lb. according to Stone). Grain straight; texture fine and even. Heartwood reddish, sapwood pale brown. Aqueous solution with light reddish or pinkish tinge.

*Growth-rings* distinct to unaided eye on cross-section, not very distinct on longitudinal surfaces; close, uniform; formed by very narrow bands of late wood; transition from early wood gradual.

*Resin-cells* at times just visible with lens on cross-section; in somewhat zonate arrangement, occasionally faintly simulating growth-rings.

*Resin-ducts* absent.

*Rays* fairly numerous, narrow, low; practically indiscernible without lens on cross-section, and not distinct with it; considerably darker than background on radial surface, and apparent to unaided eye; at limit of vision without lens in tangential view.

#### MICROSCOPIC FEATURES.

*Tracheids.*—On cross-section the tracheids are rectangular to polygonal in outline, and disposed in definite radial rows. The walls are of medium thickness, and the outline of the lumina corresponds to that of the cells themselves. Distinct but narrow growth-rings are produced by a flattened condition of the tracheids at the termination of the late wood. The transition from early wood is gradual.

As viewed on longitudinal sections and in macerated material the tracheids are rather long and broad, varying from 2.223 mm. to 4.190 mm. in length and from 0.025 mm. to 0.048 mm. in width. They commonly contain almost colourless deposits, and the tips are usually filled with reddish-brown resin. The pits in the radial walls, as seen in face view, are disposed in single rows and distinctly bordered. The mouths are narrowly lenticular (late wood) to broadly so (early wood), and do not extend to the circular or slightly oval borders, which vary in horizontal diameter from 0.008 mm. to 0.014 mm. The pits in the tangential walls of the tracheids in the late wood are rather small, but fairly abundant and distinct.

*Resin-cells.*—Resin-cells are numerous and distinct, occurring scatteringly or in irregular zonate arrangement in both early and late wood. They are partly or entirely filled with reddish-brown deposits.

*Rays.*—The slightly resinous rays are fairly numerous (6 to 11 per millimetre on cross-section), uniserial, and 1 to 27 cells high. The individual cells, as seen on tangential section, are small, thin-walled, and slightly oval in outline, with the longest axis vertical. The pits between the ray-parenchyma cells and tracheids are distinctly half-bordered, except where the borders are obscured by resin, and somewhat smaller than the tracheid pits. They are subcircular in

outline, with slit-like (late wood) to broadly-lenticular (early wood) mouths that extend to the borders. There are normally 1 to 2 pits per cross-field, although occasionally as many as 4 are found in the early wood.

*Material*.—Yale Nos. 5142, 5149, 5151, 5162.

***Podocarpus spicata* R. Br. MATAI, MAI, BLACK-PINE.**

Matai is distributed throughout both the North and South Islands, being generally found on rather dry river and shingle flats, and on the summits of ranges and spurs to an elevation of 1,800 ft., or rather higher in the North. It attains a height of 70 ft. to 80 ft. and a diameter of 2 ft. to 4 ft. The wood is used for house, bridge, and wharf construction, railroad-ties, bed-plates for machinery, crating, and rotary-cut veneer. It differs from *P. totara* as noted below.

MACROSCOPIC FEATURES.

The wood is moderately heavy, with a specific gravity of 0.682, and a weight of 42.6 lb. per cubic foot (35-49 lb.—Baterden), and the heartwood is light brown in colour, and not very sharply defined from the lighter sapwood. The aqueous solution has a very faint brownish tinge. The growth-rings are often very close and undulating. Resin-cells are absent.

MICROSCOPIC FEATURES.

The tracheids, as viewed on cross-section, are rather thick-walled and inclined to subcircular in outline, except for the radially-flattened oval cells at the termination of the late wood. The middle lamella is greenish in colour and decidedly thickened at the corners. The lumina are rounded in shape, and devoid of any contents. The length of the tracheids varies from 1.795 mm. to 4.446 mm., and the width from 0.020 mm. to 0.056 mm. Pits are entirely lacking in the tangential walls in the late wood; those in the radial walls are 0.011 mm. to 0.017 mm. in horizontal diameter.

Resin-cells are apparently lacking.

The rays are rather few (2 to 6 per millimetre on cross-section), and 1 to 38 cells high. The individual cells, on tangential section, are mostly rounded in outline. The pits between the ray-parenchyma cells and the tracheids are about as large as those in the tracheids themselves, practically filling the cross-fields; mostly 1, or occasionally 2 (early wood), per field.

*Material*.—Yale Nos. 5129, 5154, 5154A.

***Podocarpus dacrydioides* A. Rich. KAHIKATEA, WHITE-PINE.**

Kahikatea is a large tree, growing to a height of 150 ft. and a diameter of 5 ft., and often being unbranched for nearly 100 ft. It occurs in pure or mixed stands throughout both the North and South Islands, chiefly on low-lying or swampy land, or occasionally in sheltered basins on high ground or on the lower slopes of hills. The wood is utilized for crating-stock, cooperage, broom and brush stocks, spools, matches, and woodenware, as well as for turnery, rotary-cut veneer, and cabinet-work. It is also used for pipe-wood staves, and, when creosoted, for railway-sleepers. The wood is rather distinct from that of *P. Totara*.

## MACROSCOPIC FEATURES.

The wood is soft and light, with a specific gravity of 0.438 to 0.487, and a weight of 27.4 lb. to 30.4 lb. per cubic foot (26-35 lb.—Baterden), and is cream-coloured to light yellow. The aqueous solution is colourless. Resin-cells, while present, are indiscernible without a microscope. The rays are barely visible to the unaided eye on cross-section, fairly distinct on radial surface (due to difference in lustre rather than in colour), and indiscernible even with lens in tangential view.

## MICROSCOPIC FEATURES.

On cross-section the tracheids are irregularly polygonal in outline except for the radially-flattened oval cells at the termination of the late wood. The middle lamella is greenish-yellow in colour and frequently thickened at the corners, especially in the late wood. The length of the tracheids varies from 1.966 mm. to 4.959 mm., and the width from 0.031 mm. to 0.068 mm. Pits are entirely lacking in the tangential walls in the late wood; those in the radial walls are 0.008 mm. to 0.014 mm. in horizontal diameter.

Resin-cells are found scattered in the groundmass, but mostly in the late wood. They are devoid of any contents, and consequently are very indistinct on cross-section, except under high power.

The non-resinous rays are fairly numerous (5 to 11 per millimetre on cross-section), uniseriate or rarely 2-seriate in part, and 1 to 70 cells high. The half-bordered pits between the ray-parenchyma cells and tracheids are much smaller than those between tracheids themselves, and there are commonly 1, or occasionally 2 (early wood), per cross-field.

*Material.*—Yale Nos. 5131, 5133, 5133A, 5133B.

***Podocarpus ferruginea* G. Benn. MIRO, MIRO TOROMIRO, BLACK-PINE, BASTARD BLACK-PINE.**

Miro is found throughout both the North and South Islands, mostly at low altitudes on dry flats, but sometimes at fairly high elevations. It reaches a height of 40 ft. to 60 ft., with a diameter of 2½ ft. to 3½ ft. The wood is in demand for crating-stock, house-construction, and mine-timbers. It rather closely resembles totara.

## MACROSCOPIC FEATURES.

The wood is rather light, with a specific gravity of 0.571, and a weight of 35.7 lb. per cubic foot (41½-52 lb.—Stone; 46 lb.—Baterden), and is light brown in colour. The aqueous solution has a very slight pinkish tinge. Resin-cells are present, but invisible without the microscope.

## MICROSCOPIC FEATURES.

On cross-section the tracheids are irregularly quadrangular to sub-oval in outline, and the lumina are mostly somewhat rounded. Rather indistinct growth-rings are produced by a slight decrease in the size of the tracheids at the termination of the late wood. The middle lamella is light green in colour and somewhat thickened at the corners. The length of the tracheids varies from 1.624 mm. to 4.517 mm., and the width from 0.028 mm. to 0.051 mm. Pits are entirely lacking in

the tangential walls of the late-wood tracheids; those in the radial walls are 0.008 mm. to 0.014 mm. in diameter. Dark-brown resin occasionally occurs in the tracheids.

Resin-cells with dark reddish-brown contents are of rare occurrence.

The rather resinous rays are fairly numerous (4 to 11 per millimetre on cross-section), uniseriate, and 1 to 33 cells high. The individual cells are circular in outline on tangential section. The half-bordered pits between the ray-parenchyma cells and tracheids are somewhat smaller than those between the tracheids themselves, and there are mostly 1, or occasionally 2, per cross-field.

Material.—Yale Nos. 5134, 5134A, 5150.

### **Dacrydium cupressinum** Soland. RIMU, RED-PINE.

Rimu is distributed throughout both the North and South Islands, occurring along the coast, in the valleys, and on the lower slopes of the main ridges to an elevation of 2,000 ft. It attains a height of 70 ft. to 100 ft., and a diameter of 4½ ft. The wood is in demand for house, bridge, and wharf construction, mine-timber, railroad-ties, and ship planking and keels. It is also used for furniture, cabinet-work, turnery, veneer, and plywood, as well as crating-stock and cooperage. The bark yields a valuable tannin.

#### MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light and soft, easily worked; sp. gr. (air-dry), 0.583; weight, 36.4 lb. per cubic foot (33½-45 lb.—Stone). Grain straight; texture fine and even. Heartwood light brown to deep reddish-brown; sapwood without reddish tinge. Aqueous solution practically colourless. Odour not distinctive; taste slightly astringent.

*Growth-rings* fairly visible to unaided eye on cross-section, not very distinct on longitudinal section; close; formed by very slight difference in density between early and late wood; transition gradual.

*Resin-cells* barely discernible with lens on cross-section; more distinct on moist surface; much darker than background; scattered; just visible to unaided eye on longitudinal sections.

*Resin-ducts* absent.

*Rays* fairly numerous, narrow, low; mostly indiscernible without lens on cross-section; slightly darker than background on radial surface, and fairly distinct to unaided eye; practically invisible in tangential view.

#### MICROSCOPIC FEATURES.

*Tracheids.*—On cross-section the tracheids are mostly rather thin-walled and irregularly rectangular to polygonal in outline, and are disposed in definite radial rows. Very indistinct growth-rings are produced by a slightly flattened condition of the scarcely thicker-walled cells at the termination of the late wood. The lumina are somewhat irregular in shape, and frequently contain deep reddish-brown deposits. Such deposits usually occur in small localized groups, or in short radial lines, of cells.

As seen on longitudinal sections and in macerated material the tracheids are mostly long and broad, varying from 2.137 mm. to 6.036 mm. in length and from 0.017 mm. to 0.059 mm. in width.

The pits in the radial walls, in face view, are disposed in single rows, or occasionally paired in the wide tracheids, and distinctly bordered. The narrow to broadly lenticular mouths do not extend to the circular to slightly oval borders. The horizontal diameter of the borders varies from 0.010 mm. to 0.016 mm. Pits are entirely lacking in the tangential walls of the late wood.

*Resin-cells.*—The resin-cells are numerous and prominent, and are disposed scatteringly, or at times in very irregularly zonate arrangement. They contain light- to dark-red resin.

*Rays.*—The slightly resinous rays are rather few on cross-section (2 to 8 per millimetre), uniseriate, or very rarely 2-seriate in part, and 1 to 35 cells high. The individual cells as viewed on tangential section are small, thin-walled, and round to slightly elongated vertically. The pits between the ray-parenchyma cells and tracheids are mostly distinctly half-bordered, and smaller than those between tracheids; normally 1 to 2 per cross-field. The narrow to broadly lenticular mouths extend to the round or slightly horizontally-elongated borders. At times, in the early wood, the pits appear simple and very broadly lenticular in outline.

*Material.*—Yale Nos. 5138, 5140, 5140A, 5140B, 5158, 5159.

### *C. Lemoi*

**Dacrydium westlandicum** T. Kirk. SILVER-PINE, WHITE SILVER-PINE, WESTLAND PINE.

A tree, 40 ft. to 50 ft. high, found in both North and South Islands. The wood, while quite distinct from rimu, is used for much the same purposes.

#### MACROSCOPIC FEATURES.

The wood is moderately hard and heavy, with a specific gravity of 0.647, and a weight of 40.4 lb. per cubic foot (41 lb.—Baterden), light yellowish-brown in colour, and rather greasy in appearance. Although odourless, it has a decidedly bitter taste. The growth-rings are very distinct to the unaided eye on all sections. Resin-cells are absent.

#### MICROSCOPIC FEATURES.

The growth-rings are distinct, being produced by a decided flattening of the cells in the late wood, accompanied by a slight increase in the thickness of the walls. The transition from early wood is fairly gradual. The tracheids are short, but rather broad, 0.940 mm. to 2.479 mm. long, and 0.020 mm. to 0.051 mm. wide. The pits in the radial walls are 0.010 mm. to 0.014 mm. in horizontal diameter. The lumina are open.

The rays are fairly numerous (5 to 9 millimetres on cross-section), uniseriate, and 1 to 16 cells high. The individual cells on tangential section are slightly elongated vertically. The pits between the ray-parenchyma cells and tracheids are large and simple. In the late wood they are rather narrowly lenticular, and 1 per cross-field, while in the early wood they are very broadly lenticular to squarish or oblong, and 1 or 2 per field.

*Material.*—Yale Nos. 5139, 5139A, 5153.

**Dacrydium** sp. MOUNTAIN-PINE.

## MACROSCOPIC FEATURES.

The wood of the mountain-pine is rather distinct from that of rimu. It is moderately hard and heavy, weighing about 37·8 lb. per cubic foot (sp. gr. 0·605), and the light chocolate-brown heartwood is distinct from the whitish sapwood. The taste is astringent, and the aqueous solution a pronounced green. The growth-rings are distinct on all sections. Resin-cells are absent.

## MICROSCOPIC FEATURES.

The distinct growth-rings are caused by a pronounced radial flattening of one to several rows of tracheids at the termination of the late wood, accompanied by a slight thickening of the walls. The transition from the early wood is rather abrupt. The tracheids are short, but rather broad, 0·906 mm. to 2·565 mm. long and 0·017 mm. to 0·048 mm. wide. The pits in the radial walls are 0·008 mm. to 0·014 mm. in horizontal diameter. The tangential walls between the early and late wood tracheids, at the termination of the growth-ring, occasionally bear small indistinct pits.

The rays are rather few (3 to 7 per millimetre on cross-section), uniseriate, and 1 to 12 cells high. The pits between the rays and tracheids are simple, and vary from narrow-lenticular in the late wood to squarish or oblong in the early wood. There are 1 to 2 per cross-field, usually almost completely filling the field.

Material.—Yale Nos. 5143, 5152.

**Phyllocladus trichomanoides** D. Don. TANEKAHA, TAUEKAHA, CELERY-PINE, CELERY-TOPPED PINE, CELERY-LEAVED PINE.

Tanekaha occurs scatteringly in the North Island and the northern part of the South Island, from sea-level to about 2,000 ft. in altitude. The wood is used for masts and spars of ships, salt- and fresh-water piles, mine-timbers, weatherboards, flooring, cooperage, walking-sticks, and musical instruments.

## MACROSCOPIC FEATURES.

*General Properties.*—Wood moderately hard and heavy, rather easily worked; sp. gr. (air-dry), 0·645; weight, 40·3 lb. per cubic foot (47 $\frac{1}{2}$  lb.—Stone). Grain straight; texture fine and even. Heartwood light brown, at times with somewhat pinkish tinge; sapwood cream-colour. Aqueous solution light green. Odour and taste not distinctive.

*Growth-rings.*—Distinct to unaided eye on cross-section, but not very readily discernible on longitudinal surfaces; close; formed by narrow bands of denser wood; transition from early wood rather abrupt.

*Resin-cells* absent.

*Resin-ducts* absent.

*Rays* fairly numerous, narrow, very low; indiscernible without lens on cross-section; slightly darker than background, and fairly distinct to unaided eye on radial surface; practically invisible without lens in tangential view, and not distinct with it.

## MICROSCOPIC FEATURES.

*Tracheids*.—As seen on cross-section the tracheids are thin-to medium-walled, and rather irregularly polygonal in outline in the early wood, while in the late wood they become thick-walled, radially flattened, and rectangular in shape. The transition is rather abrupt. They are disposed in distinct radial rows, especially in the late wood. The lumina are irregular in outline, and commonly filled with dark to reddish-brown resin.

The tracheids vary in length from 0.684 mm. to 2.103 mm., and in width from 0.011 mm. to 0.042 mm. The pits in the radial walls, as seen in face view, are distinctly bordered and disposed in single rows. The subcircular to lenticular mouths do not extend to the rounded borders, which vary in horizontal diameter from 0.007 mm. to 0.014 mm. The pits in the tangential walls of the late-wood tracheids are rather small, fairly distinct, and numerous.

*Rays*.—The resinous rays are fairly numerous (3 to 9 per millimetre on cross-section), uniseriate, and 1 to 9 cells high. The individual cells, as viewed on tangential section, are small, thin-walled, and slightly oval in outline, with the longest axis vertical. The pits between the ray-parenchyma cells and tracheids are simple and large, usually occupying almost the entire cross-field; one per field. In the late wood they are narrow-lenticular, but in the early wood they are very broad, often somewhat squarish.

*Material*.—Yale Nos. 5132, 5137.

## 14. PINACEAE.

The pine family consists of twenty-nine genera and about two hundred and fifty species of trees and shrubs, widely distributed throughout the world, but most abundant in north temperate regions. From the standpoint of the world's timber-production this is the most important family of all, and to it belong the pines, spruces, firs, hemlocks, cypresses, and cedars. In New Zealand, however, it is represented by but two genera—*Agathis*, with a single arborescent species, and *Libocedrus*, with two.

In the woods of the Pinaceae, as in those of the Taxaceae, true vessels and wood fibres are lacking, being replaced by tracheids, which are the dominant element. While rays are always present, they are, for the most part, but 1 cell wide and normally composed of procumbent (radially-elongated) cells. In certain genera tracheids occur in the rays. Wood parenchyma (resin-cells) may or may not be present, as is also the case with resin-ducts.

***Agathis australis* Steud. (= *Dammara australis* Lamb.). KAURI-PINE, KAURI, KAWRI, COWRIE, COWDIE, NEW ZEALAND PINE, NEW ZEALAND PITCH-TREE, SOUTHERN DAMMAR.**

The kauri-pine is limited in its distribution to the very northern part of the North Island (Auckland Province). It is a large tree, attaining a height of 100 ft. to 140 ft. The wood is in demand for masts, spars, and planking of ships, flooring and inside lining of houses, shingles, framing, and interior finish of electric and railway cars, machinery-patterns, cooperage, butcher-blocks, broom and brush stocks, furniture, cabinet-work, turnery, veneers, and fixtures.

## MACROSCOPIC FEATURES.

*General Properties.*—Wood rather light but moderately hard, easily worked; sp. gr. (air-dry) 0.515; weight, 38.2 lb. per cubic foot (30-39 lb.—Baterden). Grain fairly straight, at times conspicuously mottled; texture fine and even. Colour light brown, with slight reddish tinge. Aqueous solution colourless. Odour not distinctive; taste decidedly bitter.

*Growth-rings* variable from distinct to scarcely visible without lens on cross-section; distinct on longitudinal surfaces; close to rather wide; formed by slight difference in density between early and late wood; transition gradual.

*Resin-cells* absent.

*Resin-ducts* absent.

*Rays* rather few, narrow, low; somewhat indistinct to unaided eye on cross-section; considerably darker than background and readily visible without lens on radial surface; easily discernible with naked eye in tangential view.

## MICROSCOPIC FEATURES.

*Tracheids*\*.—On cross-section the tracheids are mostly rounded to irregularly polygonal in outline, and disposed in fairly definite radial rows. Growth-rings are formed by a decided thickening of the walls of tracheids in narrow bands at the termination of the late wood. The transition from early wood is rather gradual. The middle lamella is yellowish in colour and usually thickened at the corners. Horizontal resin-plates are of common occurrence in the tracheids adjacent to the rays, appearing as distinct brownish deposits in the subcircular lumina.

On longitudinal section and in macerated material the tracheids appear as rather long, broad cells, varying in width from 0.031 mm. to 0.088 mm., and in length from 2.137 mm. to 5.643 mm. The dark-brown horizontal resin-plates are very frequent and distinct in those tracheids which are in contact with the rays. The pits in the radial walls of the tracheids, as seen in face view, are usually disposed in 2, or occasionally 1 or 3, rows. They are frequently crowded in localized groups in enlarged portions of the cells, and as a result the borders are often somewhat hexagonal in outline. The narrow to broadly lenticular mouths extend almost to the borders, which are 0.008 mm. to 0.014 mm. in horizontal diameter. The pits in the tangential walls of the late wood tracheids are confined to the walls of contact between the early and late wood cells at the termination of the growth-rings, where they are numerous and distinct.

*Rays*.—The somewhat resinous rays are rather few (2 to 7 per millimetre on cross-section), uniseriate, and 1 to 33 cells high. On tangential section the individual cells are thin-walled and subcircular in outline. The pits between the ray-parenchyma cells and tracheids are simple or indistinctly bordered, with narrow lenticular or slit-like orifices. They are numerous, 1 to 8 per cross-field.

*Material*.—Yale Nos. 5161, 5161A, 5161B.

\* See W. S. JONES: "The Structure of the Timbers of some Common Genera of Coniferous Trees," *Quarterly Journal of Forestry*, p. 18, April, 1912.

**Libocedrus Bidwillii** Hook. f. PAHAUTEA, PAUKATEA, KAWHAKA,  
CEDAR.

Pahautea is confined to the mountainous districts of the North and South Islands, at altitudes of 1,000 ft. to 3,000 ft., reaching a height of 50 ft. to 80 ft. The wood is used for bridge-building, telegraph-poles, fence posts and rails.

MACROSCOPIC FEATURES.

*General Properties.*—Wood light and soft, very easily worked; sp. gr. (air-dry) 0.413; weight, 25.8 lb. per cubic foot (28 lb.—Stone). Grain straight; texture fine and even. Heartwood reddish-brown, sapwood greyish-brown. Aqueous solution practically colourless. Odour and taste not distinctive.

*Growth-rings* mostly fairly distinct to unaided eye on cross-section, not very prominent on longitudinal surfaces; close; slightly darker than groundmass; formed by narrow bands of denser late wood; transition from early wood gradual.

*Resin-cells* at times faintly visible without lens on all sections; on cross-section disposed in irregular concentric zones, faintly simulating growth-rings.

*Resin-ducts* absent.

*Rays* fairly numerous, narrow, extremely low; barely perceptible to unaided eye on cross-section; darker than background and fairly distinct without lens on radial surface; faintly visible in tangential view.

MICROSCOPIC FEATURES.

*Tracheids.*—On cross-section the tracheids are mostly thin-walled and irregularly rectangular in outline, with squarish lumina, and disposed in definite radial rows. Growth-rings are produced by a distinct flattened condition of rather narrow zones of tracheids at the termination of the late wood, accompanied by a slight thickening of the cell-walls. The transition from early wood is gradual.

The tracheids vary in length from 1.334 mm. to 3.078 mm., and in width from 0.028 mm. to 0.045 mm. The pits in the radial walls as seen in face view, are fairly numerous but not crowded, and mostly disposed in single rows. The borders are rounded to slightly oval in outline and 0.007 mm. to 0.013 mm. in horizontal diameter, and the mouths are very small and lenticular. Pits are wholly wanting in the tangential walls of the late-wood tracheids.

*Resin-cells.*—On cross-section the resin-cells are numerous and prominent, being mostly filled with dark reddish-brown deposits. They are about the same size as the tracheids, and disposed either scatteringly, or more often in irregular zonate arrangement, toward the outside of the early wood, or less often in the late wood.

*Rays.*—The rather resinous rays are few to fairly numerous (1 to 8 per millimetre on cross-section), uniseriate, and 1 to 11, mostly 1 to 6, cells high. The individual cells, on tangential section, are uniformly circular to slightly oval in outline. The pits between the ray-parenchyma cells and tracheids are fairly numerous, 1 to 6 per cross-field. Although half-bordered, the borders are invariably obscured by the resinous contents of the rays. The mouths are lenticular and oblique.

*Material.*—Yale Nos. 5156, 5157.

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<i>Litsea calicaris</i> Kirk ..	22	<i>Tetranthera tangao</i> R. Cunn. ..	22
Mai ..	47	Thousand-jacket ..	32
Maire ..	41	Totara ..	45
Maire, white ..	41	Towai ..	25
MALVACEAE ..	32	Towhai ..	25
Manatu ..	32	Tawhai-rau-nui ..	12
Mangeao ..	22	Tawhai-rau-riki ..	14
Matai ..	47	VERBENACEAE ..	43
Manuka ..	37	<i>Vitex lucens</i> T. Kirk ..	43
MELIACEAE ..	26	<i>Weinmannia racemosa</i> Linn. f. ..	25
<i>Metrosideros lucida</i> A. Rich. ..	35	Whauai ..	32
<i>Metrosideros robusta</i> A. Cunn. ..	36	Whauwhi ..	32
Miro ..	48	Yew, New Zealand ..	45
Miro toromiro ..	48		

- 1 Kauri
- 2 Kawakha
- 3 Pahoutea
- 4 Totara
- 5 Halls Totara
- 6 P. acutifolius
- 7 P. nivalis
- 8 P. ferrugineus
- 9 P. spicatae
- 10 P. daerwydiods
- 11 Douglasia Keibii
- 12 D. beiforme
- 13 D. Bradwillii
- 14 D. Cupressinum
- 15 D. intermedium
- 16 D. Colensoi
- 17 (D. Sosifolium)
- 18 Phyllocladus Trichomanoides
- 19 P. glauca
- 20 P. Alpinae

